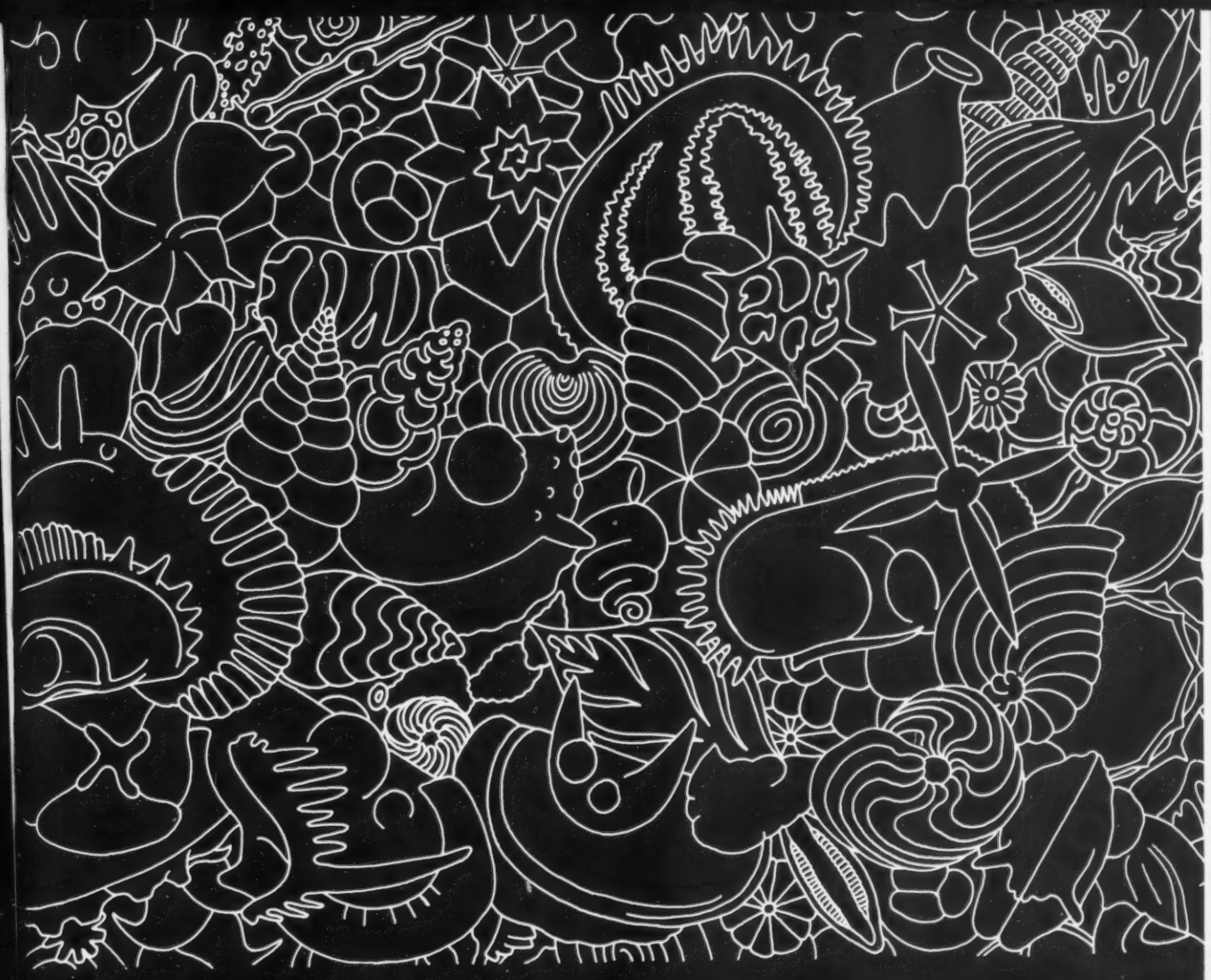

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ABSTRACT: *This study represents a survey of United States literature pertaining to ostracodes from the Mississippian, Pennsylvanian, and Permian periods. The text consists of a check list of genera and species, recording their occurrences within series. The figures consist of eleven maps of outcrops by series, with locations of areas treated in faunal papers, and one range chart of valid genera, on which the number of species within each genus is indicated.*

Survey of Mississippian, Pennsylvanian, and Permian Ostracoda recorded in the United States

DOROTHY JUNG ECHOLS AND WILGUS B. CREATH
Washington University
St. Louis, Missouri, and
Pan American Petroleum Corporation
Tulsa, Oklahoma

INTRODUCTION

A check list of all ostracode species described from the Pennsylvanian sediments of the United States was compiled several years ago in connection with the study of a Pennsylvanian ostracode fauna. Later, a check list of all Mississippian and Permian ostracodes was added to show trends in the ostracode genera within these periods.

The check list is preceded by a list of generic synonomy to facilitate the search for any particular genus. Within the check list itself, the Mississippian ostracodes are listed first under each genus, followed by the Pennsylvanian and Permian forms combined in alphabetical order.

The three periods have been divided into series following the correlation tables of Dunbar (1949), and the species have been listed in the series in which they are found. The age limits cannot be considered absolute because controversy still exists with regard to the stratigraphic position of some of the formations. The series are numbered in the check list as follows:

MISSISSIPPIAN	PENNSYLVANIAN	PERMIAN
4. Chesterian	5. Virgilian	4. Ochoan
3. Meramecian	4. Missourian	3. Guadalupian
2. Osagian	3. Desmoinesian	2. Leonardian
1. Kinderhookian	2. Atokan	1. Wolfcampian
	1. Morrowan	

The list has been compiled, it is hoped, in sufficient detail to be useful to other ostracode workers. Admittedly it will not obviate the necessity for thorough investigations by authors of future faunal papers, but it may simplify their task. It may be useful because it indicates the ranges of species, and because of the maps (text-figs. 1–11) which show the general areas of outcrop of the series and the approximate localities from which faunas have been described. The numbers on the maps correspond to the numbers in the appropriate bibliography. The bibliography is arranged stratigraphically, and each section is numbered separately. The range chart of valid ostracode genera (Chart 1) illustrates their distribution within the three periods. The actual number of species within each genus has been shown by the widths of the lines. This chart indicates at a glance the relative importance of each genus in the various series throughout the three periods.

ACKNOWLEDGMENTS

The authors are indebted to Lt. Warren Baumgartner for his work, while a graduate student at Washington University, on the preliminary listing of Pennsylvanian ostracode genera and species. They also wish to acknowledge the assistance of Mrs. Harriet Long, librarian of the geology department at Washington University, because without her untiring efforts in securing needed publications, this task could not have been accomplished. Miss Virginia Weaver and Miss Leone Ross, librarians of the Pan American Research Center, also furnished considerable assistance, for which the authors express their sincere appreciation.

GENERIC SYNONOMY

Aechmina: see *Ardmorea.*
Albanella: see *Amphissites.*
Allostracites: see *Graphiadactyllis.*
Amphissites: see *Knightina, Roundyella, Polytylites.*
Antiparaparchites = *Paraparchites* (Kellett, 1936; Agnew, 1942).
Argilloecia: see *Bythocypris.*
Bairdia: see *Bairdiacypris, Macrocypris, Haworthina, Fabalicypris.*
Bairdiacypris: see *Bairdia.*
Bairdianella: see *Macrocypris.*
Barychilina: see *Graphiadactyllis.*
Bassleria = *Graphiodactylus* (Bassler and Kellett, 1934).
Basslerina = *Hollinella* (Bassler and Kellett, 1934; Cooper, 1946).
Beyrichia: see *Hollinella, Geisina, Jonesina, Cornigella, Glyptopleurina.*
Beyrichiella: see *Geisina, Knoxina, Jonesina.*
Binodella: see *Amphissites.*
Bollia: see *Hollinella.*
Bursulella: see *Monoceratina.*
Bythocypris: see *Carbonita, Silenites, Healdia.*
Candona: see *Carbonita.*
Carbonia: see *Gutschickia, Carbonita.*
Carbonaria: see *Darwinula, Silenites.*
Carbonita: see *Candona, Darwinula.*
Cavellinella: see *Cavellina.*
Ceratopleurina: see *Glyptopleura.*
Coryella = *Knoxina* (Kellett, 1943).
Coryellina: see *Coryellites.*
Coryellites: see *Bythocypris.*
Cypris: see *Geisina, Jonesina.*
Cythere: see *Glyptopleura, Darwinula, Healdia, Paraparchites, Bairdia, Amphissites.*
Cythereis: see *Monoceratina.*
Cytherella = *Cavellina* (all Carboniferous species of *Cytherella* have been placed in the genus *Cavellina* in order to eliminate *Cytherella* from the check list; *Cythrella* is not considered a Paleozoic genus. Kellett (1935, p. 145) recommended that "all of the Carboniferous species which have been called *Cytherella* should be united with their respective female forms under the name *Cavellina.*"
Cytherella: see *Ellipsella, Moorites, Paraparchites.*
Cytherellina: see *Cavellina.*
Cytherina: see *Paraparchites.*
Cytheropsis: see *Cavellina.*
Denisonia: see *Denisonella.*
Ectodemites = *Amphissites* (considered a subgenus by Polenova, 1952; Kellett (1947, p. 179) stated: "The genus *Ectodemites* Cooper seems unacceptable, being founded on a moult of one of the species most closely related to *Amphissites rugosus* Girty, the type of the genus *Amphissites;* furthermore, there seems to be no reason for generally differentiating such forms as *Ectodemites plummeri* Cooper (1946, pl. 15, figs. 37–42) and *Amphissites congruens* Cooper (ibid., fig. 43)."
Ellipsella: see *Jonesina.*
Entomis: see *Entomozoe, Sansabella.*
Geffinina = *Knoxina.*
Geffinites = *Knoxina* (Kellett, 1947, p. 178).
Girtyites: see *Amphissites.*
Glyptopleurina: see *Moorites.*
Glyptopleurites = *Glyptopleura* (Cooper, 1941).
Graphiodactylus: see *Graphiadactyllis.*
Harltonella = *Waylandella* (Cooper, 1946).
Hollina: see *Cornigella, Hollinella.*
Hollinella: see *Glyptopleurina.*
Hollites = young *Hollinella.*
Idiomorphina: new name for *Idiomorpha,* and = *Glyptopleurina* (Cooper, 1941).
Jonesina: see *Sansabella, Sulcella, Knoxina, Perprimitia, Hollinella, Ellipsella, Geisina.*
Kegelites: new name for *Girtyites.*
Kirkbya: see *Aurikirkbya, Polytylites, Knightina, Graphiadactyllis, Amphissites, Glyptopleura.*
Kirkbyina: see *Sansabella.*
Kloedenella: see *Jonesina.*
Knightina: see *Polytylites.*
Lamarella: see *Sansabella.*
Leightonella: see *Deloia.*
Leperditia: see *Paraparchites.*
Lokius = *Perprimitia* (Cooper, 1941; but recognized by Scott, 1942).
Mammoides = *Aechminella* (Kellett, 1936, p. 771).
Mauryella: see *Polytylites.*
Microcheilus: see *Microcheilinella.*
Moorea: see *Moorites.*
Nuferella = *Jonesina* (Cooper, 1946; reestablished by Elias, 1958).
Offa: see *Discoidella.*
Paracythere: see *Graphiadactyllis.*
Paraparchites: see *Discoidella, Microparaparchites.*
Perprimitia: see *Coryellina.*
Persansabella: see *Sansabella.*
Platychilus: see *Platychilella.*
Primitiopsis: see *Venula.*
Pseudobythocypris Shaver, 1958: After the check list and range chart had been compiled, Shaver's article was published. If the following synonomies which he suggested are accepted, the genus *Bythocypris* will be practically eliminated from the range chart of Carboniferous Ostracoda of the United States. He stated: "*Pseudobythocypris* resembles some species of *Waylandella* Coryell and Billings, 1932, [= *Harltonella* Bradfield], but differs in lacking posterior ridges, shoulders, or spines. The new genus is distinguished from *Coryellites* (pro *Coryellina*) by absence of sculpture, and from all the most typical Bairdiidae (including *Bairdiacypris* Bradfield, 1935, and *Bythocypris* Brady) by possession of a more complex muscle scar but simpler contact margins without a separated calcified lamella." Shaver classified the genus *Pseudobythocypris* in the family Healdiidae, and designated *Bythocypris pediformis* Knight, 1928, as the type species. He stated further: "Probably all, or almost all, Paleozoic species of *Bythocypris* are not properly retained therein, and the author believes the following Carboniferous species are better assigned to *Pseudobythocypris*":

Bythocypris angularis, cooki, frivola, (?)irregularis, mytiliformis, and *subpediformis* Bradfield; *Bythocypris concava* and *disparilis,* and *Coryellites contracta, elongata, lowelli, portica,* and *scotti* Cooper; *Bythocypris kellettae, oblongata,* and *pecki* Cordell; *Bythocypris croneisi* Coryell and Rozanski; *Bythocypris palopintoensis, semicirculus,* and *texensis* Coryell and Sample; *Bythocypris clorensis* Croneis and Funkhouser; *Bythocypris lydeae* and *norrisensis* Geis; *Bythocypris(?) pyrula* Jones and Kirkby; *Bythocypris osagensis* Kellett; *Bythocypris exigua, gibbosa,* and *tenella* Kummerow; *Bythocypris amsdenensis* Morey; *Bythocypris bisoni* Wilson; and the Permian species *Bythocypris erectus* Harris and Worrell, and *Bythocypris johnsoni* and *tumidus* Upson.

Pterocodella = *Tetrasacculus* (Cooper, 1941).

Pterocodella: see *Triceratina.*

Reversabella = *Sansabella* (Cooper, 1941).

Reversabella: see *Lochriella.*

Sansabella: see *Entomozoe, Knoxina, Lochriella, Jonesina.*

Sansabelloides = *Sulcella* (Bassler and Kellett, 1934).

Sansabelloides: see *Cavellina.*

Savagella: see *Savagellites.*

Scaberina = *Roundyella* (Cooper, 1946).

Seminolites: see *Cribroconcha.*

Sulcella: see *Cavellina, Sargentina.*

Tetratylus = *Bufina* (Přibyl, 1953).

Triceratina = *Monoceratina* (Bassler and Kellett, 1934; reestablished by Cooper, 1941).

Ulrichia: see *Cornigella, Knightina, Beyrichiella, Kellettina, Perprimitia.*

Verrucosella = *Cornigella* (Cooper, 1941).

Waylandella: see *Healdia.*

Whipplella: see *Gutschickia, Cypridopsis, Candona.*

Whipplella = *Carbonita* (Cooper, 1946).

Workmanella = *Tetrasacculus* (Cooper, 1941).

Xestoleberis: see *Microcheilinella.*

Youngiella: see *Moorites.*

CHECK LIST OF MISSISSIPPIAN, PENNSYLVANIAN, AND PERMIAN OSTRACODES RECORDED IN THE UNITED STATES

Key to numbers: MISSISSIPPIAN: 1, Kinderhookian; 2, Osagian; 3, Meramecian; 4, Chesterian; PENNSYLVANIAN: 1, Morrowan; 2, Atokan; 3, Desmoinesian; 4, Missourian; 5, Virgilian; PERMIAN: 1, Wolfcampian; 2, Leonardian; 3, Guadalupian; 4, Ochoan.

GENERA AND SPECIES	MISS.				PENN.					PERM.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
ACRATIA Delo, 1930													
Acratia deloi Geis, 1932			×										
A. disjuncta Morey, 1935			×										
A. mucronata Cooper, 1941				×									
A. obtusa Cooper, 1941				×									
A. similaris Morey, 1936	×												
A. tumida Cooper, 1941				×									
A. inornata Cordell, 1952								×	×				
A. magna Delo, 1930							×						
A. recurvata Cordell, 1952								×	×				
A. typica Delo, 1930					Penn. shale					×			
AECHMINA Jones and Holl, 1869													
Aechmina longicornis Ulrich and Bassler, 1932		×											
AECHMINELLA Harlton, 1933													
Aechminella buchanani Harlton, 1933					×								
A. mammillata (Bradfield), 1935					×								
A. trispinosa Harlton, 1933					×								
ALLOSTRACA Ulrich and Bassler, 1932													
Allostraca fimbriata Ulrich and Bassler, 1932		×											
ALVEUS Hamilton, 1942													
Alveus depressus Hamilton, 1942													×
AMPHISSITES Girty, 1910													
Amphissites altonodosus Geis, 1932			×										
A. altonodosus var. *missouriensis* Brayer, 1952			×										
A. armatus Brayer, 1952			×										
A bicarinatus Croneis and Thurman, 1939				×									
A. bradfieldi Elias, 1958				×									
A. carinatus Cooper, 1941				×									
A. centronotoides Geis, 1932			×										
A. chappelensis Roundy, 1926				×									
A. costellifera Croneis and Bristol, 1939				×									
A. elongatus (Cooper), 1941				×									
A. exiguus Cooper, 1941				×									
A. genetivus Morey, 1935	×												
A. golcondensis Croneis and Gale, 1939				×									
A. insignis Croneis and Thurman, 1939				×									
A. latinodus Croneis and Bristol, 1939				×									
A. magnireticulatus (Cooper), 1941				×									
A. mimicus Geis, 1932			×										
A. monomastadis Coryell and Sohn, 1938				×									
A. nodosulcatus Geis, 1932			×										
A.(?) obesus Croneis and Gale, 1939				×									
A. oblongus (Jones and Kirkby), 1885				×									
Amphissites oblongus transversus (Girty), 1910				×									
A. parvus (Cooper), 1941				×									
A. peculiaris Morey, 1935	×												
A. planoventralis Geis, 1932			×										
A. planus (Cooper) (homonym of *A. planus* Wilson, 1935.)				×									
A. primus (Cooper), 1941				×									
A. quadratus Cooper, 1941				×									
A. quadratus (Cooper), 1941 (homonym of *A. quadratus* Cooper, 1941.)				×									
A. reflexus (Girty), 1910				×									
A. reticulatus Geis, 1932			×										
A. ringwoodensis Harris and Jobe, 1956				×									
A. robertsi Morey, 1935				×									
A. rotundus Geis, 1932			×										
A. rotundus var. *missouriensis* Brayer, 1952			×										
A. rugosus Girty, 1910				×	×	×							
A. similaris Morey, 1936	×												
A. simplex (Girty), 1910				×									

Genera and Species	Miss.				Penn.					Perm.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
A. springvillensis Benson and Collinson, 1958	×	×											
A. tumidus (Cooper), 1941				×									
A. sp. Crane and Kelley, 1956			×										
A. vanniae Geis, 1932			×										
A. vanniae missouriensis Brayer, 1952			×										
A. warei Morey, 1935				×									
A. adjunctio Cooper, 1946									×				
A. alticostatus Bradfield, 1935					×	×	×						
A. binoda (Bradfield), 1935					×								
A. bushi Harlton, 1935					×								
A. carinatus Cooper, 1946 (homonym of *A. carinatus* Cooper, 1941.)									×				
A. centronotus (Ulrich and Bassler), 1906						×	×	×	×				
A. centronotus (Ulrich and Bassler) var. *elongatus* Payne, 1937							×		×				
A. centronotus transversus (Roth), 1929								×					
A. cf. *A. centronotus* (Ulrich and Bassler) of Sohn, 1954										×	×		
A. ciscoensis Harlton, 1928								×	×				
A. confluens Bradfield, 1935					×								
A. congruens Cooper, 1946					×	×	×	×	×				
A. costatus (Roth), 1929					×								
A. cumingsi Bradfield, 1935					×								
A. dattonensis Harlton, 1927							×	×	×				
A. edsonae Bradfield, 1935								×					
A. geneae Roth, 1929							×	×					
A. girtyi Knight, 1928							×	×	×				
A. girtyi var. *deesensis* Bradfield, 1935								×					
A. knighti Sohn, 1954											×		
A. koehleri Delo, 1931					Miss. or U. Penn								
A. marginiferus (Roth), 1929					×								
A. menardensis Harlton, 1929								×					
A. miseri Harlton, 1933					×								
A. nodosus (Roth), 1929					×								
A. nodosus Scott and Borger, 1941-homonym of *A. nodosus* (Roth).								×					
A. parvus Cooper, 1946							×	×					
A. pinguis (Ulrich and Bassler), 1906							×	×	×	×	×		
A. robustus Cooper, 1946					×	×	×	×					
A. rothi Bradfield, 1935					×	×	×	×					
A. roundyi Knight, 1928						×	×	×					
A. simplexus (Roth), 1929					×								
A. sullivanensis Payne, 1937								×					
A. wewokanus Warthin, 1930							×						
A. sp. Harlton, 1933					×								
Ardmorea Bradfield, 1935													
Ardmorea gibberosa (Knight), 1928							×	×					
A. symmetrica Bradfield, 1935							×						
Argilloecia Sars, 1866													
Argilloecia regularis Delo, 1930								×	×	×			
Artifactella Coryell and Booth, 1933													
Artifactella tomahawki Coryell and Booth, 1933									×				
Aurigerites Roundy, 1926													
Aurigerites texanus Roundy, 1926			×										

Genera and Species	Miss.				Penn.					Perm.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
Aurikirkbya Sohn, 1950													
Aurikirkbya auriformis Sohn, 1950										×			
A. barbarae Sohn, 1950										×			
A. wordensis (Hamilton), 1942										×			
Bairdia McCoy, 1844													
Bairdia aculeata Cooper, 1941				×									
B. aequa Cooper, 1941				×									
B. attenuata Girty, 1910			×	×									
B. bedfordensis Geis, 1932			×										
B. biljohnsoni Elias, 1958				×									
B. brevis Jones and Kirby, 1879				×									
B. cestriensis Ulrich, 1891				×									
B. aff. *B. cestriensis* Ulrich, 1891		×											
B. compacta Geis, 1932			×										
B. compressa Geis, 1932			×										
B. contracta Morey, 1935				×									
B. croneisi Elias, 1958				×									
B. curvis Cooper, 1941				×									
B. delicata Morey, 1935				×									
B. distressa Geis, 1940 (new name for *B. depressa* Geis, 1932)			×										
B. fragosa Morey, 1935	×												
B. galei Croneis and Thurman, 1939				×									
B. gibbera Morey, 1935	×												
B. golcondensis Croneis and Gale, 1939				×									
B. granireticulata Harlton, 1929				×									
B. granireticulata ringwoodensis Harris and Jobe, 1956				×									
B. huffmani Harris and Jobe, 1956				×									
B. impendere Cooper, 1941				×									
B. insolens Cooper, 1941				×									
B. jobeae Harris and Jobe, 1956				×									
B. kinderhookensis Morey, 1936	×												
B. lanulata Harlton, 1929				×									
B. magnacurta Morey, 1935	×												
B. mccoyi Croneis and Gutke, 1939				×									
B. moreyi Harris and Jobe, 1956				×									
B. multihilosa Elias, 1958				×									
B. nasuta Morey, 1935				×									
B.(?) *osorioi* Croneis and Gale, 1939				×									
B. pecki Morey, 1935	×												
B. permagna Geis, 1932			×										
B. perplexa Coryell and Rozanski, 1942				×									
B. polygonata Scott, 1942				×									
B. renaultensis Croneis and Gutke, 1939				×									
B. salemensis Geis, 1932			×										
B. sinuosa Morey, 1936	×												
B. sohni Coryell and Rozanski, 1942				×									
B. sp. 1, Crane and Kelley, 1956			×										
B. subelongata Jones and Kirkby, 1879				×									
B. subequalis Geis, 1932			×										
B. submucronata Jones and Kirkby, 1879				×									
B. subparallela Morey, 1935	×												

Genera and Species	Miss.				Penn.					Perm.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
B. subrotundata Harlton, 1929				×									
B. subtila Cooper, 1941				×									
B. acuminata Cooper, 1946									×				
B. altifrons Knight, 1928					×	×	×	×	×	?			
B. angusta Cooper, 1946							×						
B. anomala Payne, 1937									×				
B. arcuata Knight, 1928							×						
B. ardmorensis Harlton, 1929					×	×	×						
B. beedei Ulrich and Bassler, 1906						×	×	×	×	×			
B. beedei var. *inflata* Payne, 1937								×	×				
B. biacuta Bradfield, 1935					×	×							
B. bicornis Bradfield, 1935								×					
B. ciscoensis Harlton, 1927									×	×			
B. concava Cooper, 1946									×				
B. conciliata Harlton, 1929					×								
B. coryelli Roth and Skinner, 1931							×	×	×				
B. crassa Harlton, 1929								×	×				
B. crassimarginata Cooper, 1946								×	×				
B. deloi Kellett, 1934										×			
B. demissa Cooper, 1946									×				
B. dissimilis Cooper, 1946						×							
B. dornickhillensis Harlton, 1929					×	×							
B. eissensis Upson, 1933										×			
B. florenaensis Upson, 1933									×	×			
B. folgeri Kellett, 1934									×				
B. forakerensis Kellett, 1934										×			
B. garrisonensis Upson, 1933								×	×	×			
B. geisi Kellett, 1934										×			
B. guadalupiana Hamilton, 1942									×	×	×		
B. harltoni Cooper, 1946						×							
B. hesslandi Upson, 1933										×			
B. hextensis Harlton, 1929									×				
B. hispida var. *lesterica* Bradfield, 1935						×							
B. hoffmanae Kellett, 1934									×				
B. hooverae Kellett, 1934									×	×			
B. ignota Bradfield, 1935							×						
B. illinoisensis Scott and Borger, 1941								×					
B. irionensis Delo, 1930					Penn. shale								
B. kansasensis Kellett, 1934							×	×	×				
B. kanwakensis Kellett, 1935								×	×				
B. kingii Reuss, 1854, of Cooper, 1946.									×	(Perm. abroad)			
B. lunata Bradfield, 1935								×					
B. macdonelli Harlton, 1929								×					
B. menardvillensis Harlton, 1929								×					
B. nevensis Kellett, 1934										×			
B. oklahomaensis Harlton, 1927							×	×	×				
B. pecosensis Delo, 1930					Penn. shale								
B. pennata Coryell and Sample, 1933						×	×	×					
B. peracuta Warthin, 1930							×						
B. perincerta Kellett, 1934								×	×				
B. permiana Hamilton, 1942										×	×	×	
B. pinnula Coryell and Booth, 1933									×				
B. plebeia reussiana (Kirkby), 1858								×	×	×			
B. pompilioides Harlton, 1928						×	.	.	.	.	.	.	×
B. powersi Kellett, 1934									×				
B. punctata Bradfield, 1935							×						
B. quadrispinosa Scott and Borger, 1941								×					
B. radlerae Kellett, 1934										×			

Genera and Species	Miss.				Penn.					Perm.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
B. recta Harlton, 1921									×				
B. regularis Cooper, 1946								×	×				
B. rhomboidalis Hamilton, 1942												×	
B. schaurothiana Kirkby, 1858					×	×							
B. scholli Coryell and Booth, 1933									×	×			
B. seligi Delo, 1930							×	×	×				
B. seminalis Knight, 1928								×	×	×	×		
B. shideleri Delo, 1930					Penn. shales								
B. spp. 1—9, Cordell, 1952									×	×			
B. sp. a, Upson, 1933					Penn. and Permian								
B. sp., Scott, 1944							×						
B. spinosa Cooper, 1946									×				
B. subfusiformis Hamilton, 1942												×	
B. subvexa Coryell and Billings, 1932										×			
B. summa Coryell and Billings, 1932									×	×			
B. symmetrica Cooper, 1946									×				
B. verwiebei Kellett, 1934										×	×		
B. wabashensis Scott and Borger, 1941									×				
B. whitesidei Bradfield, 1935							×	×					
B. whortani Kellett, 1935										×			
B. wordensis Hamilton, 1942											×	×	×
B. warthini Bradfield, 1935							×	×					
Bairdiacypris Bradfield, 1935													
Bairdiacypris acuminata Cooper, 1946									×	×	×		
B. ardua Cooper, 1946									×	×	×		
B. deloi Bradfield, 1935										×	×		
B. glennensis (Harlton), 1927									×	×			
B. punctata Scott, 1942								×	×				
B. shideleri Delo, 1930									×				
B. sp. 1, Cordell, 1952										×			
B. trojana (Wilson), 1933								×	×	×			
Bairdianella Harlton, 1929													
Bairdianella acuta Scott and Borger, 1941									×				
B. elegans Harlton, 1929									×	×			
B. oblonga Harlton, 1929									×				
B. postcompressa Cordell, 1952									×				
B. sp. 1, Cordell, 1952									×				
Bairdiolites Croneis and Gale, 1939													
Bairdiolites brevirostris Croneis and Thurman, 1939				×									
B. bulbosus Croneis and Bristol, 1939				×									
B. centroporatus Harris and Jobe, 1956				×									
B. crassus Cooper, 1941				×									
B. crescentis Croneis and Gale, 1939				×									
B. elongatus Croneis and Funkhouser, 1939				×									
B. fovealis Coryell and Rozanski, 1942				×									
B. fornicatus Cooper, 1941				×									
B. ovatus Croneis and Funkhouser, 1939				×									
B. platypleurus Croneis and Gale, 1939				×									
B. procerus Cooper, 1941				×									
B. tenuis Cooper, 1941				×									
B. vulgaris Cooper, 1941				×									

Genera and Species	Miss.				Penn.					Perm.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
Balantoides Morey, 1935													
Balantoides moreyi Croneis and Funkhouser, 1939				×									
B. quadrilobatus Morey, 1935				×									
B. reticulatus Croneis and Thurman, 1939				×	×								
Barychilina Ulrich, 1891													
Barychilina lineata Ulrich and Bassler, 1932		×											
Basslerella Kellett, 1935													
Basslerella acuminata Cooper, 1946							×	×					
B. crassa Kellett, 1935										×			
B. firma Kellett, 1935						×	×	×	×	×			
B. lacrimosa Cooper, 1946							×	×	×				
B. obesa Kellett, 1935									×				
B. ovata Cooper, 1946								×	×				
B.(?) parallela Cooper, 1946							×	×					
B. rothi Kellett, 1935										×			
B.(?) rostrata (Knight), 1928							×						
B. unispinosa Scott and Borger, 1946							×	×					
Beyrichia McCoy, 1846, emended Ulrich and Bassler, 1908													
Beyrichia contracta Cooper, 1941				×									
B. lithofactor White and St. John, 1867			×										
B. lithofactor velata White and St. John, 1867			×										
B. placida Croneis and Gale, 1939				×									
B. sagitta Cooper, 1941				×									
Beyrichiana Kellett, 1933													
Beyrichiana permiana Kellett, 1933										×			
B. tumida Scott and Borger, 1941									×				
Beyrichiella Jones and Kirkby, 1886													
Beyrichiella confluens (Ulrich), 1891			×	×									
Beyrichiopsis Jones and Kirkby, 1886													
Beyrichiopsis brynhildae Coryell and Johnson, 1939				×									
B. modesta Ulrich and Bassler, 1932	×												
B. pulchra Ulrich and Bassler, 1932	×												
B. thori Coryell and Johnson, 1939				×									
Birdsallella Coryell and Booth, 1933													
Birdsallella simplex Coryell and Booth, 1933									×				
Brillius Brayer, 1952													
Brillius distortus Brayer, 1952			×										
B. yveus Brayer, 1952			×										
Bufina Coryell and Malkin, 1936													
Bufina elliptica (Cooper), 1941				×									
B. elongata (Cooper), 1941 (homonym of *B. elongata* Coryell and Malkin, 1936.)				×									
Burlella Coryell and Booth, 1933													
Burlella pecanata Coryell and Booth, 1933									×				
Bythocypris Brady, 1880													
Bythocypris amsdensis Morey, 1935				×	×								
B. clorensis Croneis and Funkhouser, 1939													
B. concava Cooper, 1941													
B. croneisi Coryell and Rozanski, 1942													
B. fabalis Cooper, 1941													
B. fayettevillensis Harlton, 1929													
B. gibba Cooper, 1941													
B. incertus Morey, 1935	×												
B. lydeae Geis, 1932				×									
B. marginifera Geis, 1932				×									
B. modica Cooper, 1941													
B. norrisensis Geis, 1932				×									
B. opima Cooper, 1941													
B. ovata Cooper, 1941													
B. truncata Cooper, 1941													
B. angularis Bradfield, 1935								×					
B. bisoni Wilson, 1933						×							
B. bullifera Wilson, 1933						×							
B. contracta (Cooper), 1946								×					
B. disparilis Cooper, 1946									×				
B. elongata (Cooper), 1946								×					
B. erectus Harris and Worrell, 1936													
B. fabulites Warthin, 1932								×					×
B. frivola Bradfield, 1935								×					
B. haydenbranchensis Payne, 1937									×	×			
B.? irregularis Bradfield, 1935								×					
B. johnsoni Upson, 1933													
B. kellettae Cordell, 1952									×	×	×		
B. lowelli (Cooper), 1946								×					
B. mytiliformis Bradfield, 1935									×				
B. oblongata Cordell, 1952									×				
B. osagensis Kellett, 1935										×			
B. palopintoensis Coryell and Sample, 1932								×					
B. pecki Cordell, 1952									×	×			
B. pediformis Knight, 1928 (see Pseudobythocypris Shaver, 1958, in the generic synonymy)						×	×	×	×				
B. regularis Payne, 1937									×	×	?		
B. sasakwaensis Warthin, 1930								×					
B. scapha Coryell and Billings, 1932										×			
B. scotti (Cooper), 1946									×	×			
B. semicircularis Coryell and Sample, 1932								×					
B. subreniformis Bradfield, 1935 (homonym of *B. subreniformis* Kummerow, 1924.)									×				
B.(?) texana Harlton, 1929									×				
B. tomlinsoni Harlton, 1929						×	×						
B. texensis Coryell and Sample, 1932								×					

Genera and Species	Miss.				Penn.					Perm.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
Candona Baird, 1845													
Candona magnitata (Holland), 1934											×		
C. planidorsata Cooper, 1946							×						
Carbonita Strand 1928 (new name for Carbonia Jones, 1870)													
Carbonita agnes (Jones), 1870, in Cooper 1946							×						
C. bairdioides (Jones and Kirkby), 1879, in Cooper 1946									×				
C. fabulina inflata (Jones and Kirkby), 1879, in Cooper 1946									×	×			
C.(?) lenticularis (Knight),1928							×						
C. magna (Upson), 1933									×		×		
C. orbiculata Cooper, 1946						×							
C. salteriana (Jones), 1862, in Cooper 1946							×	×	×				
C.? tenuis Cooper, 1946									×				
Carboprimitia Croneis and Funkhouser, 1939													
Carboprimitia campa Cooper, 1941				×									
C. depressa Croneis and Funkhouser, 1939				×									
C. longula Cooper, 1941				×									
C. minuta Coryell and Rozanski, 1942				×									
C. rotunda Croneis and Funkhouser, 1939				×									
C. sp. cf. *C. rotunda* Croneis and Funkhouser of Elias, 1958				×									
C. roundyi Coryell and Rozanski, 1942				×									
C. spinosa Croneis and Bristol, 1939				×									
Cardiniferella Sohn, 1953													
Cardiniferella bowsheri Sohn, 1953			×	×									
Cavellina Coryell, 1928 (emended Kellett, 1935)													
Cavellina benniei (Jones, Kirkby and Brady), 1884			×										
C. bransoni (Morey), 1935				×									
C. congruens Cooper, 1941				×									
C. coryelli Croneis and Gale, 1939				×									
C. croneisi Coryell and Rozanski, 1942				×									
C. dispar Cooper, 1941				×									
C. emaciata (Geis), 1932			×										
C. exila Cooper, 1941				×									
C. geisi (Croneis and Gale), 1939				×									
C. glandella (Whitfield), 1882, in Geis 1932			×										
C. gunnelli (Morey), 1935	×												
C. hoeniri Coryell and Johnson, 1939				×									
C. librata Cooper, 1941				×									
C. longula Cooper, 1941				×									
C. moorei Harris and Jobe, 1956				×									
C. moreyi (Coryell and Rozanski), 1942				×									
C. ovatiformis (Ulrich), 1891				×									
C. parallela Croneis and Gutke, 1939				×									
C. parva Cooper, 1941				×									
C. perplexa Croneis and Funkhouser, 1939				×									
C. savagei (Geis), 1932			×										
C. spatulata Croneis and Gutke, 1939				×									
C. spergenensis (Geis), 1932			×										
C. unioniformis (Herrick), 1891	×												
C. angusta Cooper, 1946							×						
C. arcuata Coryell and Rogatz, 1932										×			
C. berwynensis(Bradfield),1935					×								
C.(?) bisecta Bradfield, 1935					×								
C. brevis (Bradfield), 1935					×								
C. brevisulcata(Bradfield),1935						×							
C. cavellinoides Bradfield, 1935					×								
C. chasensis Kellett, 1935										×			
C. constricta (Delo), 1930						Penn.				×			
C. cumingsi Payne, 1937								×	×				
C. daubeana (Bradfield), 1935							×	×					
C. edmistonae (Harris and Lalicker, 1932)									×	×			
C. ellipticalis Hamilton, 1942											×	×	
C. equalis Coryell, 1928							×						
C. expansa Bradfield, 1935							×	×					
C. fittsi Kellett, 1935							×	×	×				
C. footei Coryell and Booth, 1933								×	×				
C. incurvescens (Jones and Kirkby), 1896						×							
C. jejuna Coryell and Sample, 1932							×						
C. laevis (Bradfield), 1935							×	×	×				
C. laevissima Bradfield, 1935								×	×				
C. lintris Coryell and Sample, 1932							×	×					
C. lirata (Bradfield), 1935								×	×				
C. marmorea Kellet, 1935									×				
C. minima Coryell, 1928							×						
C. minuta Bradfield, 1935							×						
C. muhlenbergensis Scott, 1944							×						
C. nebrascensis (Geinitz), 1866									×				
C. ottervillica (Bradfield), 1935						×							
C. ottervillica obesa (Bradfield), 1935						×							
C. ovoidiformis (Harlton),1928								×	×				
C. proxima (Coryell and Sample), 1932							×						
C. pulchella Coryell. 1928							×	×	×				
C. robusta Bradfield, 1935						×							
C. rotunda Cooper, 1946							×	×					
C. subovata Coryell, 1928							×						
C. subpulchella Coryell, 1928							×						
C. symmetrica (Payne), 1937								×	×				
C. tongia (Coryell and Sample), 1932							×						
C. watkinsi (Coryell and Sample), 1932							×						
Ceratobairdia Sohn, 1954													
Ceratobairdia dorsospinosa Sohn, 1954												×	
Chesterella Croneis and Gutke, 1939													
Chesterella exuta Croneis and Gutke, 1939								×					
C. fissurata Croneis and Gutke, 1939								×					
C.(?) incerta Cooper, 1941								×					

Genera and Species	Miss.				Penn.					Perm.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
Cornigella Warthin 1930													
Cornigella golcondensis (Croneis and Gale), 1939				×									
C. tuberculospinosa (Jones and Kirkby), 1886							×						
C. binoda Kellett, 1933										×			
C. parva Kellett, 1933										×			
C. pushmatahensis Harlton, 1933					×								
Coronakirkbya Sohn, 1954													
Coronakirkbya fimbriata Sohn, 1954											×		
Coryellina Bradfield, 1935													
Coryellina elegans (Croneis and Gutke), 1939				×									
C. indistincta Coryell and Rozanski, 1942				×									
C. kurti Coryell and Rozanski, 1942				×									
C. capax Bradfield, 1935							×						
C. indicata Sohn, 1954											×		
Coryellites Kellett, 1936													
Coryellites firma (Kellett), 1936									×				
Cribroconcha Cooper, 1941													
Cibroconcha conspicua (Harlton), 1929				×									
C. costata Cooper, 1941				×									
C. fornicata Cooper, 1941				×									
Ctenobolbina Ulrich, 1890													
Ctenobolbina loculata Ulrich, 1900	×												
Cyathus Roth and Skinner, 1930													
Cyathus vetustus Cooper, 1941				×									
C. kellumi Bradfield, 1935								×	×				
C. (?) marginatus Bradfield, 1935							×						
C. striatus Cooper, 1946						×	×						
C. ulrichi Roth and Skinner, 1930						×	×						
Cypridellina Jones, 1873													
Cypridellina newelli Kellett, 1935								×	×				
C. triangulata Scott and Borger, 1941									×				
Cypridina Milne-Edwards, 1840													
Cypridina acadia Bell, 1929			×										
C. herzeri Ulrich, 1891	×	×											
C. subovata Ulrich and Bassler, 1906									×				
Cypridopsis Brady and Norman, 1889											×		
Cypridopsis ovata (Holland), 1934													
C. parvula (Holland), 1934											×		
Darwinula Jones, 1885													
Darwinula hollandi Scott, 1944										×			
D. pungens (Jones and Kirkby), 1867							×						
Deloia Croneis and Thurman, 1939													
Deloia serrata Croneis and Thurman, 1939				×									

Genera and Species	Miss.				Penn.					Perm.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
D. spinosa Croneis and Bristol, 1939				×									
D. sulcata Croneis and Funkhouser, 1939				×									
D. tumida Cooper, 1941				×									
Denisonella Croneis and Bristol, 1942													
Denisonella brevicosta (Cooper), 1941				×									
D. cincta (Croneis and Bristol), 1939				×									
D. cirrata (Cooper), 1941				×									
Dilobella Ulrich, 1894 (emended Kay, 1940)													
Dilobellea texana Coryell and Booth, 1933									×				
Discoidella Croneis and Gale, 1939													
Discoidella ampla Cooper, 1941				×									
D. pendens Croneis and Gutke, 1939				×									
D. simplex Croneis and Gale, 1939				×									
D. convexa Scott and Borger, 1941								×	×				
D. lingulata Cooper, 1946								×	×				
D. perminuta (Kellett), 1933									×				
Dizygopleura Ulrich and Bassler, 1923													
Dizygopleura mehli Morey, 1935	×												
Editia Brayer, 1952													
Editia elegantis Brayer, 1952			×										
Ellipsella Coryell and Rogatz, 1932													
Ellipsella bradfieldi Cooper, 1946								×					
E. calcar (Harlton), 1928								×	×	×	×		
E. obliqua Coryell and Rogatz, 1932												×	
Entomozoe Pribyl, 1951													
Entomozoe unicornis (Girty), 1909			×										
Eukloedenella Ulrich and Bassler, 1923													
Eukloedenella distressa Scott, 1942				×									
Fabalicypris Cooper, 1946													
Fabalicypris acuminata Cooper, 1946								×					
F. dispar Cooper, 1946								×					
F. minuta Cooper, 1946						×		×					
F. plana Cooper, 1946								×					
F. pulcher Cordell, 1952									×				
F. sp. 1, Cordell, 1952									×				
F. subelliptica Cordell, 1952									×				
F. regularis Cooper, 1946						×							
F. tenuis Cooper, 1946						×							
F. wetumkaensis Cooper, 1946						×	×	×					
F. wileyensis Cooper, 1946						×	×	×					
Geisina Johnson, 1936													
Geisina arcuata (Bean), 1836					×	×	×						
G. gallowayi (Bradfield), 1935							×						

Genera and Species	Miss.				Penn.					Perm.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
G. gregaria (Ulrich and Bassler), 1906							×	×					
G. papillosa (Harris and Lalicker), 1932										×			
G. papillosa inflata (Harris and Lalicker), 1932										×			
G. primitioides (Harris and Lalicker), 1932										×			
G. upsoni (Kellett), 1935										×			
G. warthini Cooper, 1946							×						
Gillina Coryell and Johnson, 1939													
Gillina vitharri Coryell and Johnson, 1939				×									
Glyptopleura Girty, 1910													
Glyptopleura adunca Croneis and Thurman, 1939				×									
G. alata Croneis and Funkhouser, 1939				×									
G. alternata Croneis and Funkhouser, 1939.				×									
G. alvea Cooper, 1941				×									
G. angulata Girty, 1910				×									
G. belphegora Brayer, 1952			×										
G. bicarinata Scott, 1942				×									
G. bristoli Croneis and Gutke, 1939				×									
G. brunoa Brayer, 1952			×										
G. campaui Crane and Kelley, 1956			×										
G. carinata Geis, 1932			×										
G. carrolli Croneis and Bristol, 1939				×									
G. circumcostata Cooper, 1941				×									
G. complexa Croneis and Funkhouser, 1939				×									
G. compta Croneis and Thurman, 1939				×									
G. conflexacostata Croneis and Gale, 1939				×									
G. cooperi Elias, 1958				×									
G. costata (McCoy), 1844			×										
G. cuneata Crane and Kelley, 1956			×										
G. (?) curvata Croneis and Gale, 1939				×									
G. decacostata Croneis and Gale, 1939				×									
G. embryonica Brayer, 1952			×										
G. elegantis Geis, 1932			×										
G. elephanta Brayer, 1952			×										
G. elliptica Croneis and Gutke, 1939				×									
G. friggae Coryell and Johnson, 1939				×									
G. geisi Elias, 1958				×									
G. genevievea Brayer, 1952			×										
G. gibba Croneis and Gale, 1939			×										
G. gloriosa Scott, 1942				×									
G. hamatilis Croneis and Bristol, 1939				×									
G. harltoni Croneis and Bristol, 1939				×									
G. henbesti Croneis and Gutke, 1939				×									
G. hendricksi Croneis and Gutke, 1939				×									
G. inopinata Girty, 1910				×									

Genera and Species	Miss.				Penn.					Perm.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
G. intermedia Croneis and Gale, 1939				×									
G. karli Geis, 1932				×									
G. kayi Croneis and Bristol, 1939				×									
G. kellettae Croneis and Thurman, 1939				×									
G. michaelis Brayer, 1952			×										
G. multicostata Morey, 1935			×	×									
G. omerensis Crane and Kelley, 1956			×										
G. parvacostata Geis, 1932			×										
G. pentacostata Croneis and Gale, 1939				×									
G. perbella Geis, 1932			×										
G. pseudosulcata Croneis and Thurman, 1939				×									
G. quadricostata Scott, 1942				×									
G. reniformis Croneis and Thurman,1939				×									
G. sp. cf. *reniformis* Harris and Jobe, 1956				×									
G. resupinata Croneis and Bristol, 1939				×									
G. sabota Brayer, 1952			×										
G. sagae Coryell and Johnson, 1939				×									
G. salemensis Coreyll and Brackmier, 1931			×										
G. schizopleura Coryell and Sohn, 1938				×									
G. scotti Elias, 1956				×									
G. similis Croneis and Funkhouser, 1939				×									
G. sp., Coryell and Rozanski, 1942				×									
G. sp. 1, Crane and Kelley, 1956			×										
G. symmetrica Croneis and Funkhouser, 1939				×									
G. teretiformis Croneis and Thurman, 1939				×									
G. tyri (Coryell and Johnson), 1939				×									
G. varians Croneis and Funkhouser, 1939				×									
G. varicostata Croneis and Thurman, 1939				×									
G. venosa (Ulrich), 1891				×									
G. warthini Elias, 1958				×									
G. winfieldi (Scott), 1942				×									
G. zara Brayer, 1952			×										
G. coryelli Harlton, 1931								×	×				
G. emarginata Delo, 1930					Penn. shale								
G. irregularis Delo, 1931					Mid. or Up. Penn.								
G. menardensis Harlton, 1929								×					
G. texana Harlton, 1929								×					
G. triserta Harris and Lalicker, 1932												×	
G. whitei Bradfield, 1935						×							
Glyptopleurina Coryell, 1928													
Glyptopleurina? bulbosa Croneis and Gale, 1939				×									
G. chadwicki (Coryell and Rozanski), 1942				×									
G. complexa Croneis and Bristol, 1939				×									
G. coryelli Croneis and Gutke, 1939				×									
G. flexuosa Cooper, 1941				×									
G. iniqua Cooper, 1941				×									

Genera and Species	Miss.				Penn.					Perm.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
G. insculpta (Croneis and Funkhouser), 1939				×									
G. insignis (Croneis and Gale), 1939				×									
G. longuronis Cooper, 1941				×									
G. malkinae (Coryell and Rozanski), 1942				×									
G. oehersi (Croneis and Bristol), 1939				×									
G. ornata (Croneis and Gale), 1939				×									
G. simplex Croneis and Bristol, 1939				×									
G. simulans Croneis and Gutke, 1939				×									
G. simulatrix (Ulrich), 1891				×									
G. vetula Cooper, 1941				×									
G. montifera Coryell, 1928							×						
G. powersi Harlton, 1929								×					
Glyptopleuroides Croneis and Gale, 1939													
Glyptopleuroides girtyi Croneis and Gutke, 1939				×									
G. insculptus Croneis and Gale, 1939				×									
G. perplexus Croneis and Gutke, 1939				×									
G. reticulatus Coryell and Rozanski, 1942				×									
Golcondella Croneis and Gale, 1939													
Golcondella sulcata Croneis and Gale, 1939				×									
Graphiadactyllis Roth, 1929													
Graphiadactyllis arkansana (Girty), 1910				×									
G. axea Brayer, 1952			×										
G. cornutus (Ulrich and Bassler), 1932 [1929	×	×											
G. fayettevillensis (Harlton),	×	×	×	×									
G. fernglenensis Benson, 1955		×											
G. granopunctatus (Ulrich and Bassler), 1932	×	×											
G. sp. aff. *G. lineatus* (Ulrich and Bassler), 1932 of Benson, 1955		×											
G. minutus (Morey), 1936	×												
G. moridgei Benson, 1955	×	×											
G. spinosus (Morey), 1935	×												
G. subquadratus (Morey), 1935	×												
G. tumidus (Morey), 1935	×												
G.(?) unionensis Benson and Collinson, 1958	×	×											
G. walteri (Morey), 1935	×												
Gutschickia Scott, 1944													
Gutschickia levis Cooper, 1946							×						
G. ninevehensis (Holland), 1934									×	×			
G. ovata Cooper, 1946							×						
G. subangulata (Jones and Kirkby), 1879									×				
Halliella Ulrich, 1891													
Halliella? retiformis Girty, 1910				×									
Hardinia Coryell and Rozanski, 1942													
Hardinia concava Coryell and Rozanski, 1942				×									

Genera and Species	Miss.				Penn.					Perm.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
Hastacypris Croneis and Gutke, 1939													
Hastacypris bradyi Croneis and Gutke, 1939				×									
Hastifaba Cooper, 1946													
Hastifaba pervulgata Cooper, 1946							×						
H. robusta Cooper, 1946							×						
H. spinosa Cooper, 1946									×				
Haworthina Kellett, 1935													
Haworthina salmonae Coryell and Rozanski, 1942				×									
H. bulleta (Harris and Lalicker), 1932									×	×			
Healdia Roundy, 1926 (emended Harlton, 1929)													
Healdia aequabills Cooper, 1941				×									
H. ampla Roundy, 1926		×											
H. bluefieldana Coryell and Sohn, 1938				×									
H. caneyensis Harlton, 1927				×	×								
H. cornigera (Jones and Kirkby), 1895				×									
H. decora Morey, 1936	×												
H. elliptica Cooper, 1941				×									
H. exilis Cooper, 1941				×									
H. fayettevillensis Harlton, 1929				×									
H. sp. cf. *H. fayettevillensis* Harlton, 1929				×									
H. goniapleura Croneis and Bristol, 1939				×									
H. harltoni Elias, 1958				×									
H.(?) menardensis Croneis and Bristol, 1939				×									
H. menisca Cooper, 1941				×									
H. minuta Cooper, 1941				×									
H. mucronata Cooper, 1941				×									
H. opima Croneis and Gale, 1939				×									
H. ornata Morey, 1935			×	×									
H. ovoidea Cooper, 1941				×									
H. radinula Cooper, 1941				×									
H. simplex Roundy, 1926				?			×	×	×				
H. subcarinata Morey, 1935	×												
H. sulcata Cooper, 1947				×									
H. tenuicostata Cooper, 1941				×									
H. variolosa Geis, 1932			×										
H. vinitaensis Harlton, 1929				×									
H. absentia Coryell and Billings, 1932									×				
H. ackersi Delo, 1930					Penn. Shale								
H. ap. aff. *H. ampla* Roundy of Bradfield, 1935					×								
H. alba Coryell and Billings, 1932									×				
H.(?) arca Bradfield, 1935							×						
H. asper Cooper, 1946							×						
H. aspinosa Cooper, 1946								×	×				
H. bendana Bradfield, 1935					×								
H. bicornis Cooper, 1946								×					
H. boggyensis Harlton, 1927						×	×						
H. cara Bradfield, 1935							×						
H. carinata Cooper, 1946								×					
H. carterensis Bradfield, 1935							×						
H. cincta Coryell and Billings, 1932									×				
H. ciscoensis Harlton, 1927										×			

Genera and Species	Miss.				Penn.					Perm.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
H. colonyi Coryell and Booth, 1933							×	×					
H. compressa Coryell and Billings, 1932									×				
H. concinna Delo, 1930					Penn. shale								
H. coryelli Kellett, 1936									×				
H. cuneata Coryell and Billings, 1932									×				
H. cuneiformis Bradfield, 1935							×	×					
H. ehlersi Bradfield, 1935							×	×					
H. elegans Warthin, 1930							×						
H. fabalis Cooper, 1946						×							
H. formosa Harlton, 1928					?	×	×						
H. glennensis Harlton, 1927						×	×						
H. glennensis Harlton var., Marple, 1952						×							
H. granosa Cooper, 1946							×						
H. humilis Bradfield, 1935							×	×					
H. lentiformis Delo, 1930					Penn. shale								
H. limacoidea Knight, 1928							×						
H. longula Cooper, 1946						×	×						
H. marginata Harlton, 1928				×	×	×	×						
H. masoni Coryell and Booth, 1933									×				
H. miranda Coryell and Billings, 1932									×				
H. nucleolata Knight, 1928							×						
H. oblonga Bradfield, 1935							×						
H. obsolens Delo, 1930					Penn. shale								
H. sp. cf. *H. obsolens* Delo, 1930					Penn. shale								
H. oklahomaensis Harlton, 1927							×	×	×				
H. ovata Bradfield, 1935								×					
H. overbrookensis Harlton, 1927						×							
H. parallela Kellett, 1935										×			
H. punctata McLaughlin, 1952						×							
H. quadrispinosa Coryell and Billings, 1932									×				
H. rectis Cooper, 1946								×					
H. simplicissima Harlton, 1933						×							
H. sp. Bradfield, 1935						×							
H. squamosa Harlton. 1928				×	×								
H. subangularis Delo, 1930					Penn. shale								
H. spinosa Cooper, 1946								×					
H. torquata Harlton, 1928									×				
H. tulsaensis Coryell and Osorio, 1932								×					
H. unispinosa Hamilton, 1942										×	×		
H. unispinosa McLaughlin, 1952 (homonym)							×	×					
H. usitata Cooper, 1946								×					
H. vidriensis Hamilton, 1942										×	×		
H. winfieldensis Upson, 1933										×			
Healdiacypris Bradfield, 1935													
Healdiacypris subtriangularis Coryell and Rozanski, 1942				×									
H. subtriangularis tuberculata Coryell and Rozanski, 1942				×									
H. acuminata Cooper, 1946				×									
H. perplexa Bradfield, 1935				×									
Healdioides Coryell and Rozanski, 1942													
Healdioides bradfieldi Coryell and Rozanski, 1942				×									

Genera and Species	Miss.				Penn.					Perm.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
H. diversus Coryell and Rozanski, 1942				×									
H. diversus spinosus Coryell and Rozanski, 1942				×									
Hilboldtina Scott and Summerson, 1943													
Hilboldtina multiplicata Scott and Summerson, 1943						×							
Hollinella Coryell, 1928 (emended Kellett, 1929)													
H. granifera (Ulrich), 1891			×	×									
H. longispina (Jones and Kirkby), 1886				×									
H. radiata (Jones and Kirkby), 1867				×									
H. radiata dotti Elias, 1958				×									
H. typica Morey, 1935				×									
H. swania Brayer, 1952			×										
H. australis Delo, 1930					Penn. shale								
H. bassleri (Knight), 1928							×	×	×				
H. burlingamensis Kellett, 1933								×	×				
H. crassimarginata Kellett, 1929								×	×				
H. cushmani Kellett, 1933								×	×				
H. dentata Coryell, 1928						×	×	×					
H. dissimilis Tasch, 1953									×				
H. elongata Cooper, 1946								×					
H. emaciata (Ulrich and Bassler), 1906												×	
H. gibbosa Kellett, 1929									×			×	
H. grahamensis (Harlton), 1927									×				
H. grandis Cooper, 1946								×	×				
H. herrickiana (Girty), 1909									×			×	
H. kellettae Knight, 1928 in Kellett, 1933								×					
H. levis Cooper, 1946								×					
H. limata (Moore), 1929									×				
H. minuta Cooper, 1946								×					
H. nevensis Kellett, 1929												×	
H. nowataensis Coryell and Osorio, 1932								×					
H. occidentalis (Girty), 1910													×
H. oklahomaensis (Harlton), 1929								×	×				
H. papillosa (Coryell and Sample), 1932								×	×				
H. pulchra (Moore), 1929								×	×				
H. radlerae (Harlton), 1929									×				
H. recurva (Moore), 1929								×	×				
H. regularis Coryell, 1928									×				
H. shawneensis Kellett, 1929									×				
H. subquadrata Delo, 1930					Penn. shale								
H. warthini Cooper, 1946								×					
H. ulrichi (Knight), 1928								×	×				
Hypotetragona Morey, 1935													
Hypotetragona impolita Morey, 1935	×												
Incisurella Cooper, 1941													
Incisurella lata Cooper, 1941				×									
I. prima Cooper, 1941				×									
Jonesina Ulrich and Bassler, 1908 (emended Cooper, 1941)													
Jonesina arcuata (Bean), 1836				×	×								
J. craterigera (Jones and Kirkby), 1885				×									

Genera and Species	Miss.				Penn.					Perm.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
J. equilatera Cooper, 1941				×									
J. fragilis Scott, 1942				×	×								
J. insculpta Croneis and Funkhouser, 1939				×									
J. intermedia Croneis and Bristol, 1939				×									
J.(?) judithensis Scott, 1942				×									
J. lalickeri Croneis and Bristol, 1939				×									
J. lombardensis Scott, 1942				×									
J. oblonga Geis, 1932			×										
J. odini Coryell and Johnson, 1939				×									
J. papei Scott, 1942				×									
J. persulcata Croneis and Gale, 1939				×									
J. puncta Morey, 1935			×	×									
J. reticulata Harlton, 1929				×									
J. sinuodorsata Geis, 1932			×										
J.(?) skinneri Croneis and Gale, 1939				×									
J. spinigera Croneis and Funkhouser, 1939				×									
J. tenuisinuosa Cooper, 1941				×									
J. biformis Bradfield, 1935						×	×						
J. bradyana (Jones and Kirkby), 1886							×				×		
J. carbonifera Girty, 1910										×			
J. daubeana Bradfield, 1935							×	×					
J. deesensis Bradfield, 1935							×						
J. dubia Bradfield, 1935							×						
J. elongata Cooper, 1946									×				
J. gallowayi Bradfield, 1935							×						
J. garrisonensis Upson, 1933										×			
J. grahamensis Coryell and Booth, 1933									×				
J. gregaria (Ulrich and Bassler), 1906							×	×					
J. mccoyi Roth and Skinner, 1930							×						
J. prolata Delo, 1930					Penn. shale								
J. subquadrata Delo, 1930					Penn. shale								
J. trisulcata Bradfield, 1935							×						
J. uncialis Harris and Lalicker, 1932										×			
Kellettella Delo, 1930													
Kellettella incarinata Geis, 1932			×										
K. naviculata Delo, 1930								×					
Kellettina Swartz, 1936													
Kellettina binoda (Roth and Skinner), 1930							×	×					
K. montosa (Knight), 1928							×	×					
K. robusta (Kellett), 1933										×	×	×	
Kindlella Sohn, 1954													
Kindlella centrinoda Sohn, 1954										×	×		
K. fissiloba Sohn, 1954										×	×		
Kirkbya Jones 1859 (emended Knight, 1928; emended Roth, 1929)													
Kirkbya aequalis Croneis and Funkhouser, 1938				×									
K. sp. cf. *K. bendensis* Harlton of Elias, 1958				×									
K. bifrons Croneis and Thurman, 1939				×									
K. dorsoconvexa Geis, 1932			×										

Genera and Species	Miss.				Penn.					Perm.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
K. elongata Cooper, 1941				×									
K. fernglenensis Benson, 1955	×	×											
K. fossula Croneis and Bristol, 1939				×									
K. humerosa Cooper, 1941				×									
K. intermedia Croneis and Thurman, 1939				×									
K. keiferi Benson, 1955		×											
K. marginata Croneis and Funkhouser, 1939				×									
K. sp. cf. *K. oblonga* Jones and Kirkby of Harris and Jobe, 1956				×									
K. penichia Brayer, 1952			×										
K. sp. cf. *K. reflexa* Girty of authors (not *Amphissites reflexus* (Girty), 1910				×									
K. regularia Croneis and Gale, 1939				×									
K. rothi Geis, 1932			×										
K. symmetrica Croneis and Thurman, 1939				×									
K. turrita Croneis and Gale, 1939				×									
K. welleri Geis, 1939				×									
K. arcuata Roth, 1929								×					
K. bendensis Harlton, 1933					×	×							
K. clarocarinata Knight, 1928							×	×	×				
K. distenta Roth, 1929								×					
K. firma Kellett, 1933							×	×	×				
K. inornata Roth, 1929					×								
K. jolliffana Bradfield, 1935					×								
K. kellettae Harlton, 1929								×	×	×			
K. laciniata Knight, 1928							×						
K. magna (Roth), 1929					×								
K. moorei Kellett, 1933										×			
K. obliqua Bradfield, 1935								×					
K. pergrandis Kellett, 1933									×				
K. scaphula Knight, 1928							×						
K. texana Harlton, 1928									×				
K. tumida Roth, 1929								×					
K. voluta Knight, 1928							×						
K. wordensis Hamilton, 1942													
K. wymani Kellett, 1933											×		×
K. sp. Bradfield, 1935						×							
Kirkbyella Coryell and Booth, 1933													
Kirkbyella annensis Benson and Collinson, 1958	×	×											
K.(?) dubia Morey, 1936	×												
K. gutkei Croneis and Bristol, 1939				×									
K. ozarkensis Morey, 1936	×	×											
K. quadrata Croneis and Gutke, 1939				×									
K. scapha Morey, 1935	×												
K. sulcata Cooper, 1941				×									
K. truncata Cooper, 1941				×									
K. sp. cf. *K. gutkei* Croneis and Bristol of Cooper, 1946					×								
K. typa Coryell and Booth, 1933									×				
Kirkbyina Ulrich and Bassler, 1908													
Kirkbyina inflata Harlton, 1929									×	×	×		
K. laevis Warthin, 1930							×						
K. spinosa Harlton, 1929					×								

Genera and Species	Miss.				Penn.					Perm.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
Kirkbyites Johnson, 1936													
Kirkbyites upsoni Johnson, 1936								×					
Kloedenella Ulrich and Bassler, 1908 (emended Ulrich and Bassler, 1923)													
Kloedenella macer Cooper, 1941				×									
Kloedenellina Coryell and Johnson, 1939													
Kloedenellina heimdalli Coryell and Johnson, 1939				×									
Knightina Kellett, 1933													
Knightina neglecta Croneis and Gale, 1939				×									
K. pinguoides Croneis and Gale, 1939				×									
K. allerismoides (Knight), 1928							×						
K. ampla Kellett, 1933									×				
K. bassleri Kellett, 1933										×			
K.(?) cuestaforma Sohn, 1954											×		
K. fidlari Payne, 1937								×	×				
K. fidlari oblonga Payne, 1937								×	×				
K. harltoni Kellett, 1933								×					
K. hextensis (Harlton), 1929								×					
K. incurva Kellett, 1933										×			
K. kellettae Bradfield, 1935					×								
K.? macknighti Sohn, 1954										×	×		
K. minuta (Harris and Lalicker), 1932								×	×	×			
K. perplexa (Roth), 1929								×					
K. texana (Harlton), 1928									×	×			
Knoxina Coryell and Rogatz, 1932													
Knoxina inflata Croneis and Gale, 1938				×									
K. johnsoni (Coryell and Sohn), 1938				×									
K. jungae (Coryell and Sohn) 1938				×									
K. mammoides (Coryell and Sohn), 1938				×									
K. marmerae (Coryell and Sohn), 1938				×									
K. praelonga (Cooper), 1941				×									
K. reticulata (Scott), 1942				×									
K. rogatzi Croneis and Gutke, 1939				×									
K. bolliaformis (Ulrich and Bassler), 1906									×	×			
K. lecta Coryell and Rogatz, 1932											×		
K. texana (Harlton), 1929								×	×				
Leperditia Rouault, 1851													
Leperditia juvenis Croneis and Gale, 1938				×									
Lochriella Scott, 1942													
Lochriella fenriri (Coryell and Johnson), 1939				×									
L. otterensis Scott, 1942				×									
L. reversa (Morey), 1935				×									
L. seageri Scott, 1942				×									
L. subventricosa Scott, 1942				×	×								
L. ampla Cooper, 1946									×				
L.(?) angusta Cooper, 1946							×						
L. elongata Cooper, 1946									×				

Genera and Species	Miss.				Penn.					Perm.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
Macrocypris Brady, 1868													
Macrocypris acuminata Cooper, 1941				×									
M. biconcava Croneis and Gutke, 1939				×									
M. chapmani Croneis and Bristol, 1939				×									
M. ovata Cooper, 1941				×									
M. reginni Coryell and Johnson, 1939				×									
M. bicurvata Cooper, 1946									×				
M. delicatula Bradfield, 1935								×	×				
M. garrisonensis Upson, 1933													×
M. illinoiensis Scott and Borger, 1941									×				
M. lenticularis Cooper, 1946									×				
M. menardensis Harlton, 1929									×				
M. occidentalis (Girty), 1909													×
M. teretis Cooper, 1946								×					
Mauryella Ulrich and Bassler, 1923													
Mauryella mammillata Ulrich and Bassler, 1923	×												
M. sp., Roth and Skinner, 1930								×					
Mesoglypha Cooper, 1941													
Mesoglypha mediocre Cooper, 1941				×									
Microcheilinella Geis, 1933													
Microcheilinella acuminata Coryell and Rozanski, 1942				×									
M. cordata Cooper, 1941				×									
M. distorta (Geis), 1932			×										
M.(?) exilis Cooper, 1941				×									
M. obesa Cooper, 1941				×									
M. ovata Coryell and Rozanski, 1942				×									
M. pergracilis Croneis and Gale, 1939				×									
M. spinosa (Geis), 1932			×										
M. subcorbuloides (Jones and Kirkby), 1885				×									
M. tumida Cooper, 1941				×									
M. bicornata Cooper, 1946									×				
M. compacta Cordell, 1952									×	×			
M. inflata Kellett, 1935										×	×		
M. minuta Cooper, 1946							×						
M. parva Cordell, 1952									×	×			
M. quadrata Cooper, 1946								×					
M. unispinosa Cooper, 1946										×			
M. sp. 1, Cordell, 1952									×				
Microcoelonella Coryell and Sohn, 1938													
Microcoelonella scanta Coryell and Sohn, 1938				×									
M. symmetrica Scott, 1942				×									
Microparaparchites Croneis and Gale, 1939													
Microparaparchites erectus Cooper, 1941				×									
M. inornatus Croneis and Bristol, 1939				×									
M. spinosus Croneis and Gale, 1939				×									
M. angustus Cooper, 1946								×					
M. brazoensis (Coryell and Sample), 1932								×					

Genera and Species	Miss.				Penn.					Perm.				
	1	2	3	4	1	2	3	4	5	1	2	3	4	
M. cornutus Cooper, 1946							×							
M. cuneatus (Warthin), 1930							×							
M. elongatus Cooper, 1946							×							
M. ovatus Cooper, 1946							×							
M. quadratus Cooper, 1946							×							
M. wapanuckaensis (Harlton), 1928							×							
Miltonella Sohn, 1950														
Miltonella shupei Sohn, 1950										×				
Monoceratina Roth, 1928														
Monoceratina celsalobata Cooper, 1941				×										
M.(?) elongata Benson and Collinson, 1958	×	×												
M. furcula Croneis and Gale, 1939				×										
M. opima Cooper, 1941				×										
M. postnodosa Harris and Jobe, 1956				×										
M. tennesseensis (Ulrich and Bassler), 1932		×												
M. ardmorensis (Harlton), 1927					×									
M. bradfieldi Cooper, 1946									×					
M. dornickhillica Bradfield, 1935					×									
M. huddlei Bradfield, 1935					×									
M. lewisi Harris and Laiicker, 1932										×				
M. macoupeni Scott and Borger, 1941									×					
M.(?) nodosa Scott and Borger, 1941									×					
M. ventralis Roth, 1928					×									
M. ventralis magna Roth, 1928									×					
Moorea Jones and Kirkby, 1869														
Moorea? circincta Cooper, 1941				×										
M. granosa Ulrich, 1891				×										
M. elongata Coryell and Sample, 1932							×							
Mooreina Harlton, 1933														
Mooreina johnsvalleyensis Harlton, 1933					×									
Moorites Coryell and Billings, 1932														
Moorites brevis Cooper, 1941				×										
M. convexus Cooper, 1941				×										
M. intermedius Cooper, 1941				×										
M. rhomboidalis (Croneis and Bristol), 1939				×										
M. elongatus? (Jones and Kirkby), 1886				×			×	×	×					
M. indentus Cooper, 1946							×							
M. knighti (Wilson), 1933						×	×	×	×					
M. minutus (Warthin), 1930							×	×	×					
M. parallela Coryell and Sample, 1932							×							
M. punctus (Wilson), 1933						×	×	×						
M. spiciferus (Wilson), 1933						×	×							
M. wapanuckensis (Harlton), 1933						×	×	×						
Neobeyrichiopsis Tasch, 1953														
Neobeyrichiopsis emporiensis Tasch, 1953									×					

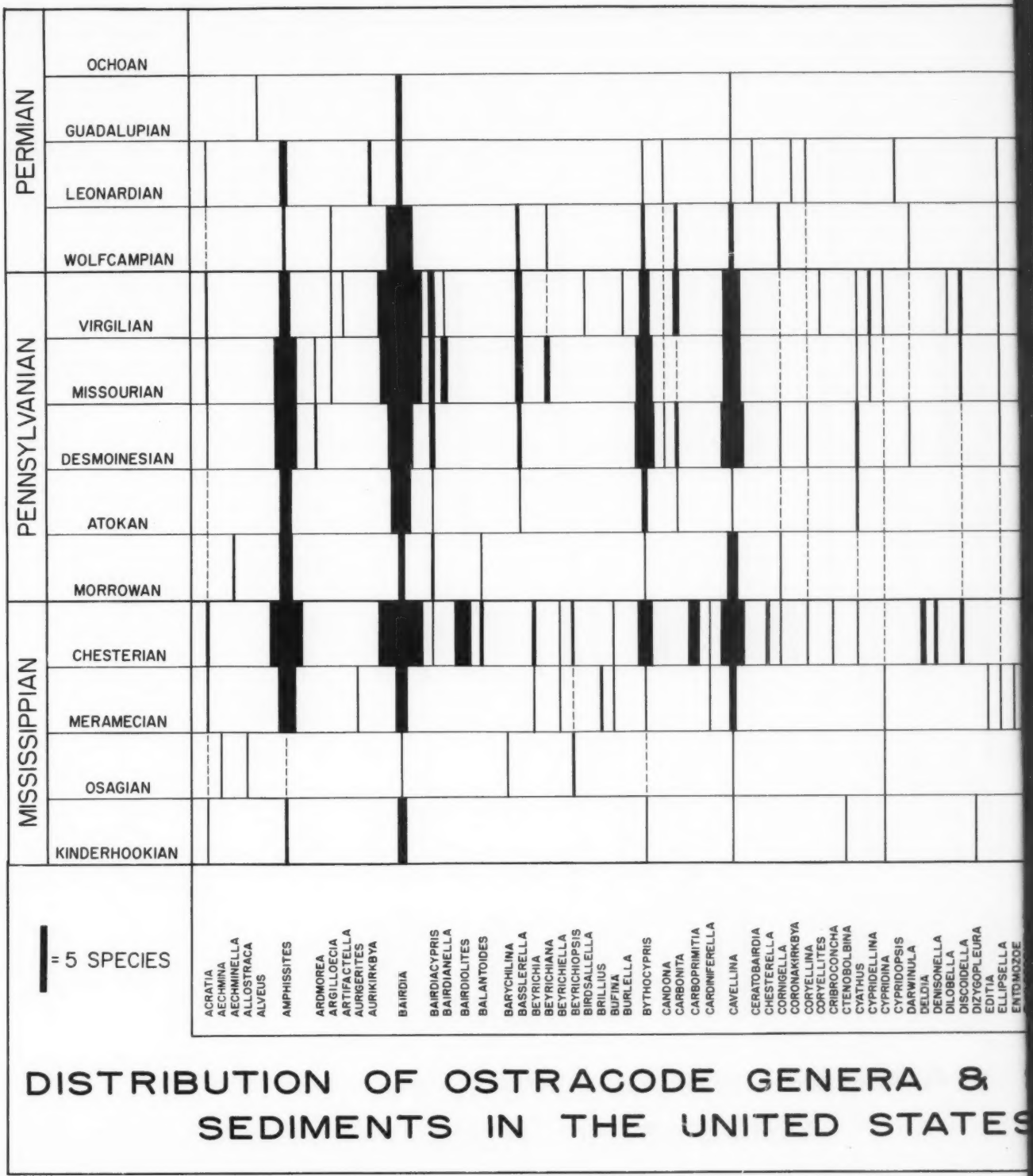
Genera and Species	Miss.				Penn.					Perm.				
	1	2	3	4	1	2	3	4	5	1	2	3	4	
Neokloedenella Croneis and Funkhouser, 1939														
Neokloedenella? magna Cooper 1941								×						
N. ovulella Coryell and Rozanski, 1942								×						
N.(?) pollakae Coryell and Rozanski, 1942								×						
N. prima Croneis and Funkhouser, 1939								×						
N. secunda Croneis and Bristol, 1939								×						
N. subquadrata Croneis and Gutke, 1939								×						
Nuferella Bradfield, 1935														
Nuferella infrequens Bradfield, 1935									×					
N. rothi Elias, 1958								×						
N. wellsi Coryell and Sohn 1938								×						
Oliganisus Geis, 1932														
Oliganisus geisi Croneis and Gutke, 1939								×						
O. punctatus Geis, 1932							×							
O. sulcatus Geis, 1932							×							
Paracavellina Cooper, 1941														
Paracavellina elliptica Cooper, 1941								×						
P. elliptica manningensis Harris and Jobe, 1956								×						
P. opima Cooper, 1941								×						
P. ovata Cooper, 1941								×						
P. pinguis Cooper, 1941								×						
P. tumida Cooper, 1941								×						
Paraparchitella Cooper, 1946														
Paraparchitella ovata Cooper, 1946									×					
Paraparchites Ulrich and Bassler, 1906														
Paraparchites bigsnowyensis Scott, 1942								×						
P. carbonarius (Hall), 1856							×							
P. cyclopeus (Girty), 1910								×						
P. disjunctus Morey, 1935	×													
P. distortus Coryell and Rozanski, 1942								×						
P. sp. cf. *P. elongatus* Bradfield of Elias, 1958								×						
P. emaciatus Scott, 1942								×						
P. gibbus Bell, 1929							×	×						
P. inornatus (McCoy), 1844								×	×	×	×	×	×	×
P. kinkaidensis Croneis and Thurman, 1939								×						
P. manningensis Harris and Jobe, 1956								×						
P. nicklesi (Ulrich), 1891	×	×	×	×	×									
P. oblongus (Coryell and Rozanski) [not Jones and Kirkby, 1865, nor Coryell and Sample, 1932]								×						
P. ovatus Cooper, 1941								×						
P. projectus Harris and Jobe, 1956								×						
P. robustus Croneis and Gutke, 1939								×						

Genera and Species	Miss.				Penn.					Perm.				
	1	2	3	4	1	2	3	4	5	1	2	3	4	
P. samueli Coryell and Rozanski, 1942				×										
P. subcircularis Geis, 1932			×											
P.(?) ardmorensis Bradfield, 1935							×	×						
P. bimammatus Delo, 1930					Penn.shale									
P. claytonensis Knight, 1928							×							
P. dispar Cooper, 1946							×							
P. dornickhillicus Bradfield, 1935						×								
P. elongatus Bradfield, 1935					×									
P. exiguus Cooper, 1946							×							
P. fabula Cooper, 1946							×							
P. gibbosus Upson, 1933										×				
P. guthreyi Bradfield, 1935					×									
P. harltoni Bradfield, 1935							×							
P. humerosus Ulrich and Bassler, 1906										×				
P. humerosus texanus Delo, 1930					Penn.shale									
P. laduensis Knight, 1928							×							
P. magnus Kellett, 1933									×					
P. marathonensis Hamilton, 1942										×				
P. ornatus Delo, 1930					Penn.shale									
P. oviformis Coryell and Rogatz, 1932										×				
P.(?) perminutus Kellett, 1933								×		?				
P. punctatus Harris and Worrell, 1936										×				
P. wabashensis (Payne), 1937								×	×					
P. reversus (Coryell and Rogatz), 1932										×				
P. semicircularis Cooper, 1946						×								
Paragraphylus Coryell and Rozanski, 1942														
Paragraphylus reticulatus Coryell and Rozanski, 1942				×										
Perprimitia Croneis and Gale, 1939														
Perprimitia arenacensis Crane and Kelley, 1956			×											
P.(?) bicornis Croneis and Gale, 1938				×										
P. coryelli (Scott), 1942				×										
P. elegans Croneis and Gutke, 1939				×										
P. elongata Cooper, 1941				×										
P. fraileyi Coryell and Rozanski, 1942				×										
P. funkhouseri Croneis and Thurman, 1939				×										
P. matheri Croneis and Bristol, 1939				×										
P. rhomboidea Crane and Kelley, 1956			×											
P. robusta Croneis and Gale, 1939				×										
P. sigynae (Coryell and Johnson)				×										
P. spp. 1—4, Crane and Kelley, 1956			×											
P. tenera Cooper, 1941				×										
P. turrita Croneis and Gutke, 1939				×										
Plagionephrodes Morey, 1935														
Plagionephrodes marginatus Morey, 1935	×													
P. uninodosus Morey, 1935	×													

Genera and Species	Miss.				Penn.					Perm.				
	1	2	3	4	1	2	3	4	5	1	2	3	4	
Platychilella Cooper, 1942														
Platychilella ovoides (Cooper), 1942				×										
Polytylites Cooper, 1941														
Polytylites ambitus Cooper, 1941				×										
P. biforatus (Croneis and Thurman), 1939				×										
P. bradfieldi (Croneis and Funkhouser), 1939				×										
P. concavus (Croneis and Bristol), 1939				×										
P. coryelli Elias, 1958				×										
P. crassus Cooper, 1941				×										
P. directus Cooper, 1941				×										
P. diversus Cooper, 1941				×										
P. elongatus (Croneis and Bristol), 1939				×										
P. fossilis (Croneis and Thurman), 1939				×										
P. geniculatus Cooper, 1941				×										
P. grovei (Croneis and Gutke), 1939				×										
P.(?) kellettae Elias, 1958				×										
P. levinsoni Elias, 1958				×										
P. lobatus Harris and Jobe, 1956				×										
P.(?) nodobliquus (Croneis and Gale), 1939				×										
P. quincollinus (Harlton), 1929				×										
P. reticulatus Cooper, 1941				×										
P. similis (Croneis and Gale), 1939				×										
P. sublineatus (Croneis and Thurman), 1939				×										
P. superus (Croneis and Gale), 1939				×										
P. tricollinus (Jones and Kirkby), 1886				×										
P. trilobus (Croneis and Gale), 1939				×										
P. wilsoni (Croneis and Gutke), 1939				×										
P. digitatus Sohn, 1954														×
P. wapanuckensis (Harlton), 1929									×					
Pontocypris Sars, 1866														
Pontocypris? acuminata Ulrich 1891	×													
P. bassleri Morey, 1935	×													
P. billingsella Geis, 1932			×											
P. coryelli Geis, 1932			×											
P. pulchra Scott, 1942				×										
Primitia Jones and Holl, 1865 (emended Swartz, 1936)														
Primitia cestriensis Ulrich, 1891				×										
P. cestriensis caldwellensis Ulrich, 1891				×										
P. fayettevillensis Girty, 1910				×										
P. granimarginata Ulrich, 1891				×										
P. moorfieldana Girty, 1911		×	×											
P. seminalis Girty, 1910				×										
P. simulans Ulrich, 1891				×										
P. subaequata Ulrich, 1891				×										

Genera and Species	Miss.				Penn.					Perm.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
Proparaparchites Cooper, 1941													
Proparaparchites fabulus Cooper, 1941				×									
P. ovatus Cooper, 1941				×									
P. parallelus Cooper, 1946								×					
Pruvostina Scott and Summerson, 1943													
Pruvostina wanlessi Scott and Summerson, 1943					×								
Pseudoparaparchites Kellett, 1933													
Pseudoparaparchites? acilis Croneis and Thurman, 1939				×									
P. kansensis Kellett, 1933									×				
Roundyella Bradfield, 1935													
Roundyella mopacifica Benson, 1955	×	×											
Roundyella simplicissima (Knight), 1928			×							×			
R. bellatula Bradfield, 1935				×	×								
R. dorsopapillosa Sohn, 1954										×	×		
R. nodomarginata (Bradfield), 1935									×				
Sanniolus Sohn, 1954													
Sanniolus sigmoides Sohn, 1954										×	×		
Sansabella Roundy, 1926													
Sansabella amplectans Roundy, 1926				×	?	?	×						
S. ampla Cooper, 1941				×									
S. amsdenensis Morey, 1935				×									
S. bella Scott, 1942				×									
S. bradfieldi (Coryell and Sohn), 1938				×									
S. declivis Cooper, 1941				×									
S. dubia Morey, 1935		×											
S. elongata Cooper, 1941				×									
S. harrisi Croneis and Funkhouser, 1939				×									
S. inflata Geis, 1932			×										
S. keslingi Elias, 1958				×									
S. lenticularis Cooper, 1941				×									
S. njorthi (Coryell and Johnson), 1939				×									
S. ovata Cooper, 1941				×									
S. simplex Coryell and Rozanski, 1942				×									
S. sulcata Roundy, 1926				×									
S. truncata Cooper, 1941				×									
S. sp. cf. *S. truncata* Elias, 1958				×									
S. tumida Coryell and Sohn, 1938				×									
S. vinitaensis (Harlton), 1929				×									
S. brevis Cooper, 1946									×				
S. carbonaria Cooper, 1946								×	×				
S. exilis Cooper, 1946							×						
S. laevis (Warthin), 1930				×	.	×	×	×					
S. ovalis Cooper, 1946								×	×				
S. shumardiana (Girty), 1909									×				
S. stewartae Marple, 1952						×							
Sargentina Coryell and Johnson, 1939													
Sargentina allani Coryell and Johnson, 1939				×									

Genera and Species	Miss.				Penn.					Perm.			
	1	2	3	4	1	2	3	4	5	1	2	3	4
S. sp. cf. *S. allani* Elias, 1958				×									
S. asulcata Cooper, 1941				×									
S. crassimarginata (Croneis and Thurman), 1939				×									
S. elongata Cooper, 1946									×				
S. tumida Cooper, 1936								×					
Savagellites Pribyl, 1953													
Savagellites? acuminatus (Cooper), 1941				×									
S. lindahli (Ulrich), 1891			×	×									
S. rhomboidalis (Girty), 1915				×									
Seminolites Coryell, 1928													
Seminolites conspicuus Harlton, 1929				×									
S. impressus Coryell and Rozanski, 1942				×									
S. ovalis Cooper, 1941				×									
S.(?) reversus Cooper, 1941				×									
S. sohni Croneis and Bristol, 1939				×									
S. symmetricus Cooper, 1941				×									
S. elongatus Coryell, 1928							×						
S. extensus Coryell, 1928								×					
S. healdoides Bradfield, 1935							×						
S. kosomensis Harlton, 1933					×								
S. ovatus Delo, 1930					Penn.shale								
S. perforatus Harlton, 1933					×								
S. pushmatahensis Harlton, 1933					×								
S. subtriangularis Harlton, 1929					×								
Semipetasus Sohn, 1954													
Semipetasus signatus Sohn,1954												×	×
Silenites Coryell and Booth, 1933													
Silenites marginiferus (Geis), 1932	×	×	×										
S. warei Morey, 1936	×												
S. asymmetrica Cooper, 1946						×							
S. fabalis Cooper, 1946							×						
S. lenticularis (Knight), 1928							×	×	×				
Sulcella Coryell and Sample, 1932													
Sulcella celsa Cooper, 1941				×									
S. decora Morey, 1935	×												
S. nodocosta Cooper, 1941				×									
S. ovata Cooper, 1941				×									
S. sulcata Coryell and Sample, 1932		×	×										
Tetrasacculus Stewart, 1936													
Tetrasacculus? stewartae Benson and Collinson, 1958	×	×											
T. mirabilis (Croneis and Gale), 1939				×									
Triceratina Upson, 1933 (= Monoceratina Roth, 1928 (part) of Bassler and Kellett, 1934; reestablished by Cooper, 1941)													
Triceratina inconsueta (Croneis and Gutke), 1939				×									
Ulrichia Jones, 1890													
Ulrichia tenuimuralis Ulrich and Bassler, 1932		×											



DISTRIBUTION OF OSTRACODE GENERA & SEDIMENTS IN THE UNITED STATES

CODE GENERA & SPECIES IN M

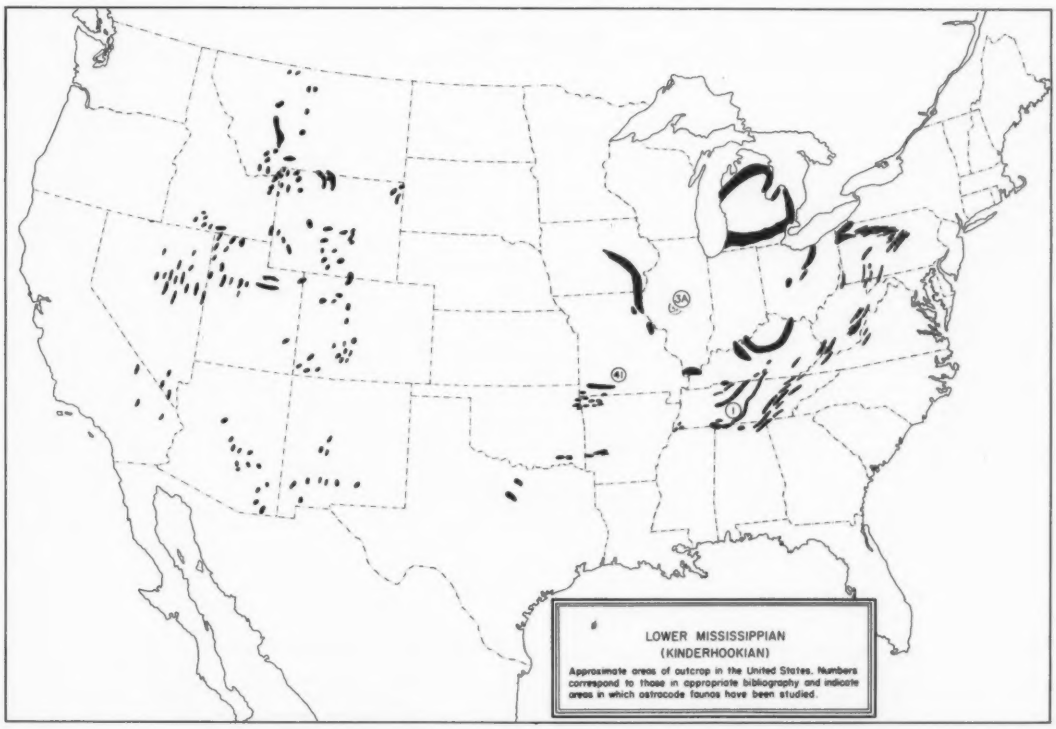
HE UNITED STATES : WIDTH OF L

N MISSISSIPPIAN – PENNSYLVANIAN – PERMIAN

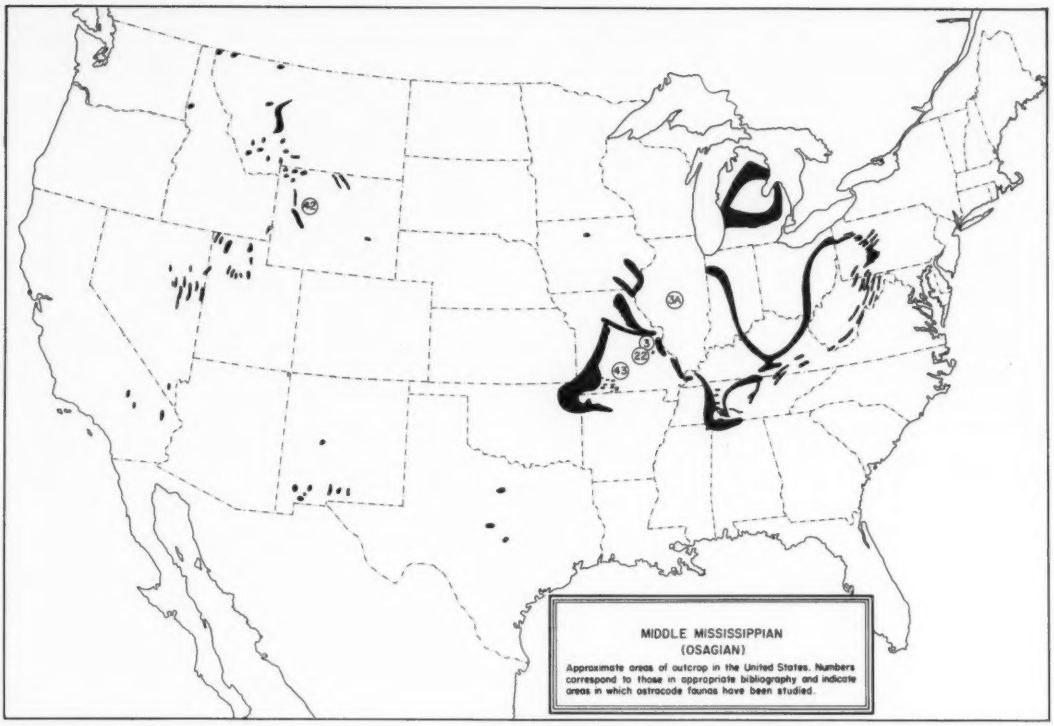
F LINE DENOTES NUMBER OF SPECIES

Genera and Species	Miss.				Penn.					Perm.				
	1	2	3	4	1	2	3	4	5	1	2	3	4	
U. binoda Roth and Skinner, 1930							×							
U. minuta Harris and Lalicker, 1932										×				
Varix Cooper, 1947														
Varix propria Cooper, 1947				×										
Venula Cooper, 1941														
Venula striata (Croneis and Funkhouser), 1939				×										
Waylandella Coryell and Billings, 1932														
Waylandella dartyensis Benson and Collinson, 1958	×	×												
W. perplexa Morey, 1935	×													
W. ardmorensis (Bradfield), 1935					×	×	×							
W. bythocyproidea (Warthin), 1930							×							

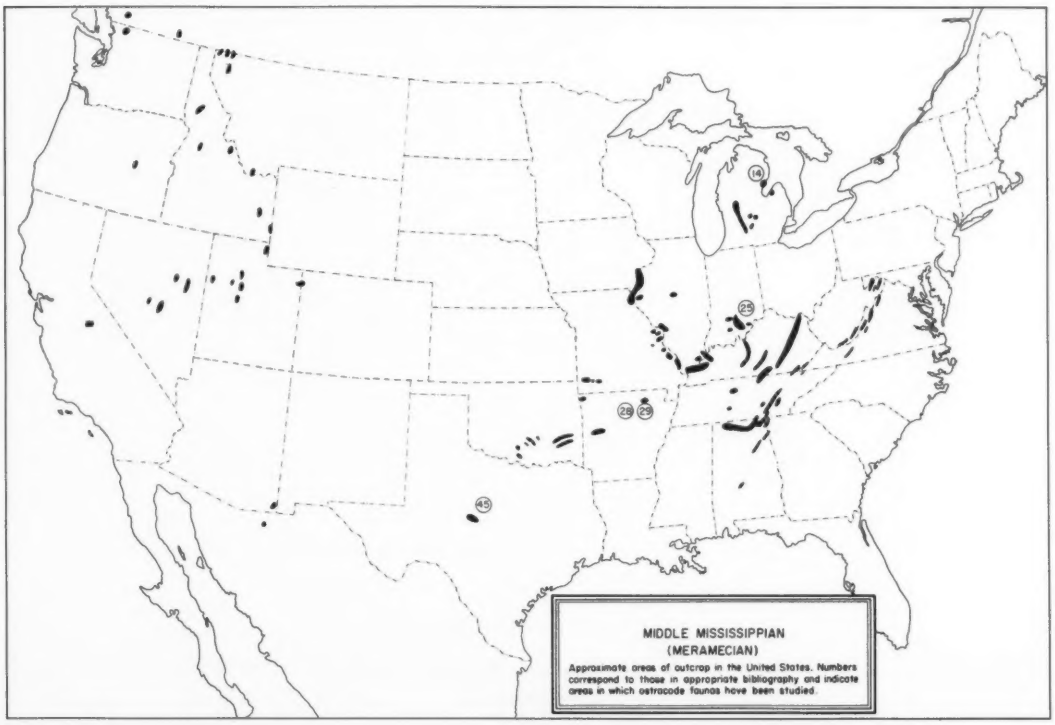
Genera and Species	Miss.				Penn.					Perm.				
	1	2	3	4	1	2	3	4	5	1	2	3	4	
W. cuyleri Coryell and Booth, 1933								×	×					
W. dispar Cooper, 1946							×							
W. fornicata Coryell and Billings, 1932									×					
W. mcalesterensis Wilson, 1933						×	×							
W. obesa Cooper, 1946							×							
W. regularis Cooper, 1946							×							
W. spinosa Coryell and Billings, 1932									×					
W. symmetrica Cooper, 1946							×							
W. (?) unicornuta Cordell, 1952								×	×					
W. vulgaris Cooper, 1946						×	×							
W. waylandica Coryell and Billings, 1932									×					
Youngiella Jones and Kirkby, 1895														
Youngiella? nodosa Harris and Jobe, 1956			×											


LOWER MISSISSIPPIAN
(KINDERHOOKIAN)
Approximate areas of outcrop in the United States. Numbers correspond to those in appropriate bibliography and indicate areas in which ostracode faunas have been studied.

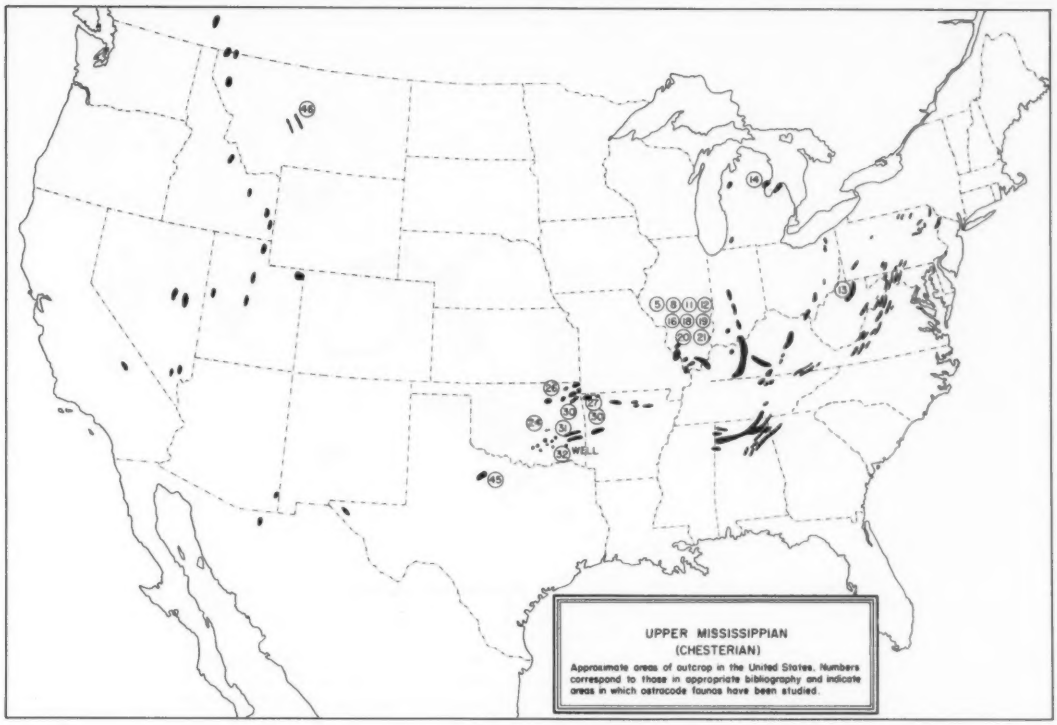
TEXT-FIGURE 1


MIDDLE MISSISSIPPIAN
(OSAGIAN)
Approximate areas of outcrop in the United States. Numbers correspond to those in appropriate bibliography and indicate areas in which ostracode faunas have been studied.

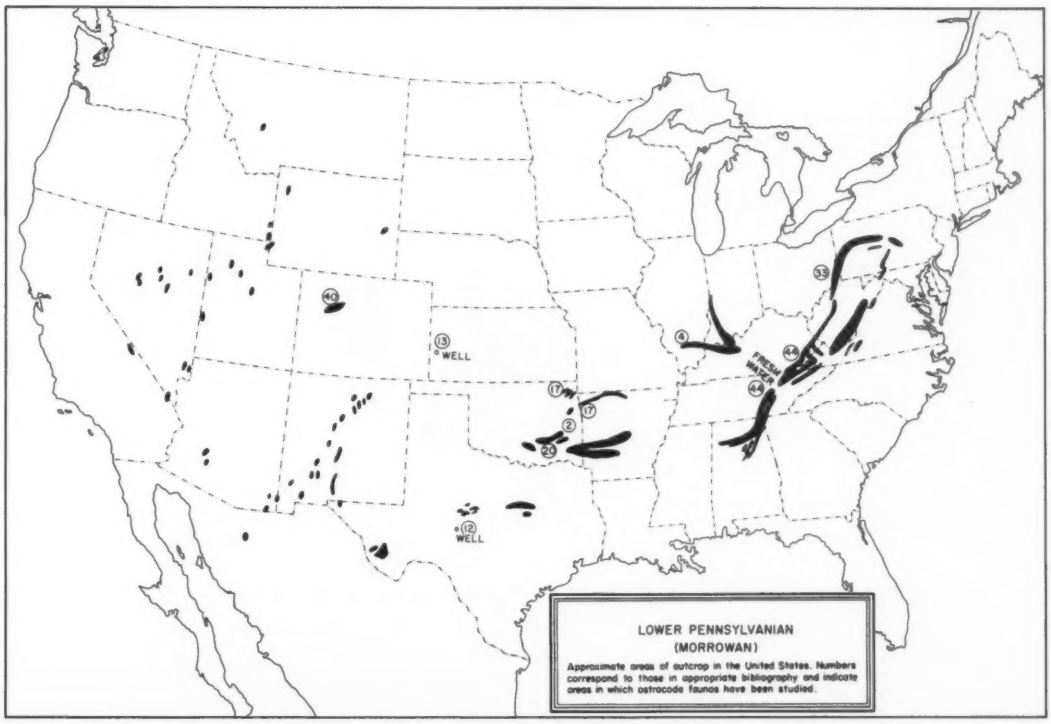
TEXT-FIGURE 2


MIDDLE MISSISSIPPIAN
(MERAMECIAN)
Approximate areas of outcrop in the United States. Numbers correspond to those in appropriate bibliography and indicate areas in which ostracode faunas have been studied.

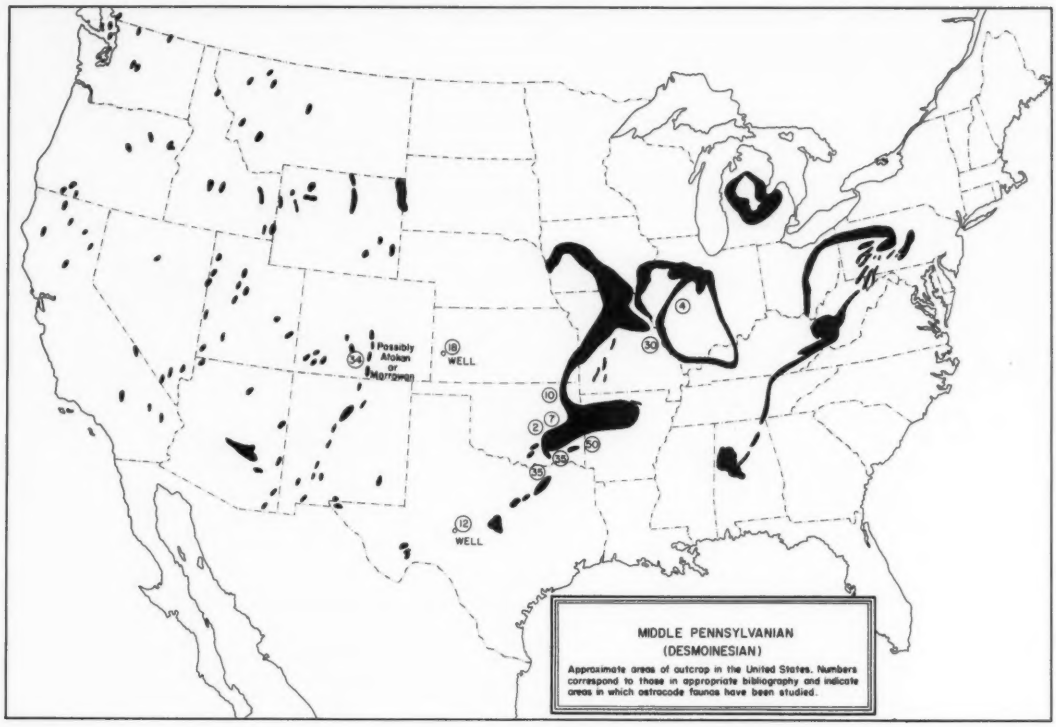
TEXT-FIGURE 3


UPPER MISSISSIPPIAN
(CHESTERIAN)
Approximate areas of outcrop in the United States. Numbers correspond to those in appropriate bibliography and indicate areas in which ostracode faunas have been studied.

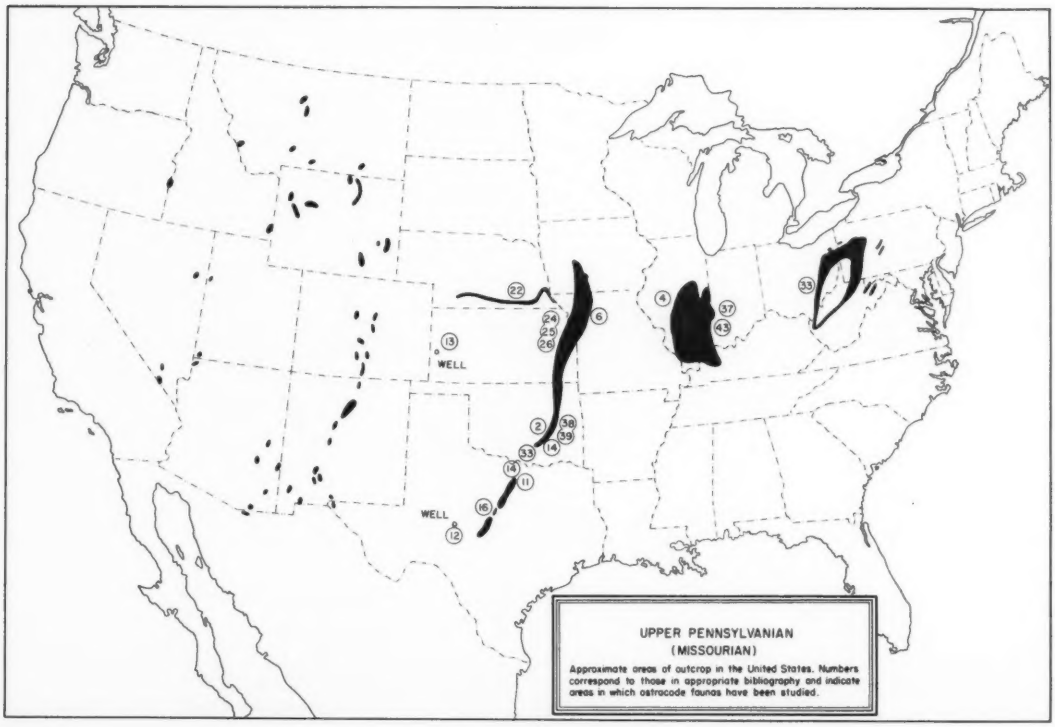
TEXT-FIGURE 4


LOWER PENNSYLVANIAN
(MORROWAN)
Approximate areas of outcrop in the United States. Numbers correspond to those in appropriate bibliography and indicate areas in which ostracode faunas have been studied.

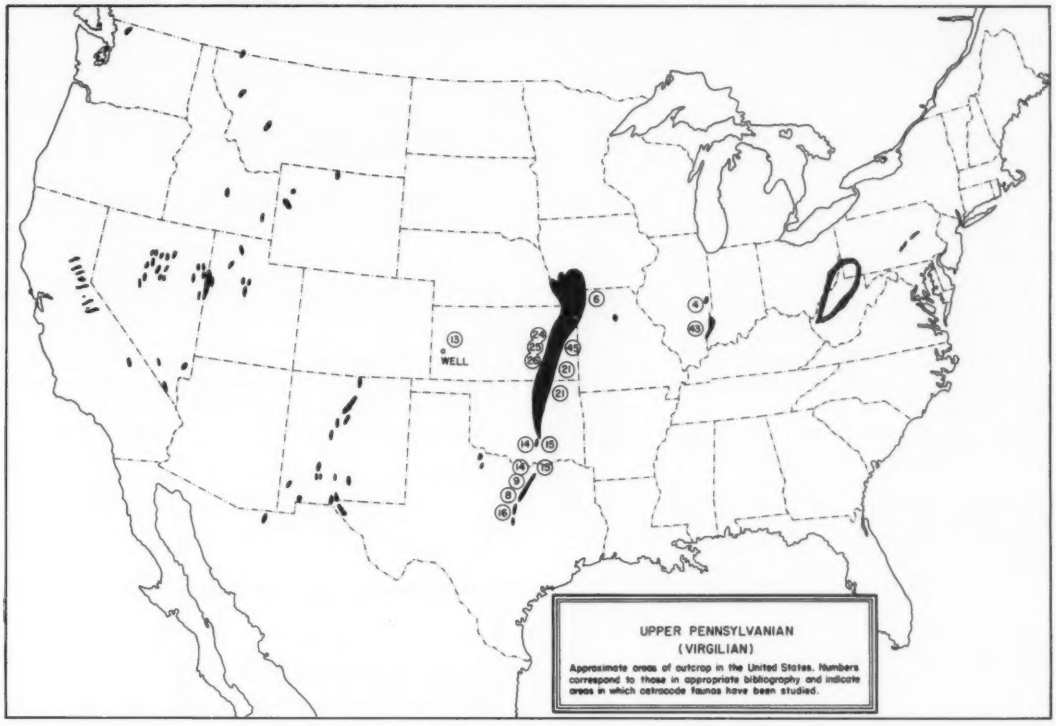
TEXT-FIGURE 5


Possibly Atokan or Morrowan
WELL
WELL
MIDDLE PENNSYLVANIAN
(DESMOINESIAN)
Approximate areas of outcrop in the United States. Numbers correspond to those in appropriate bibliography and indicate areas in which ostracode faunas have been studied.

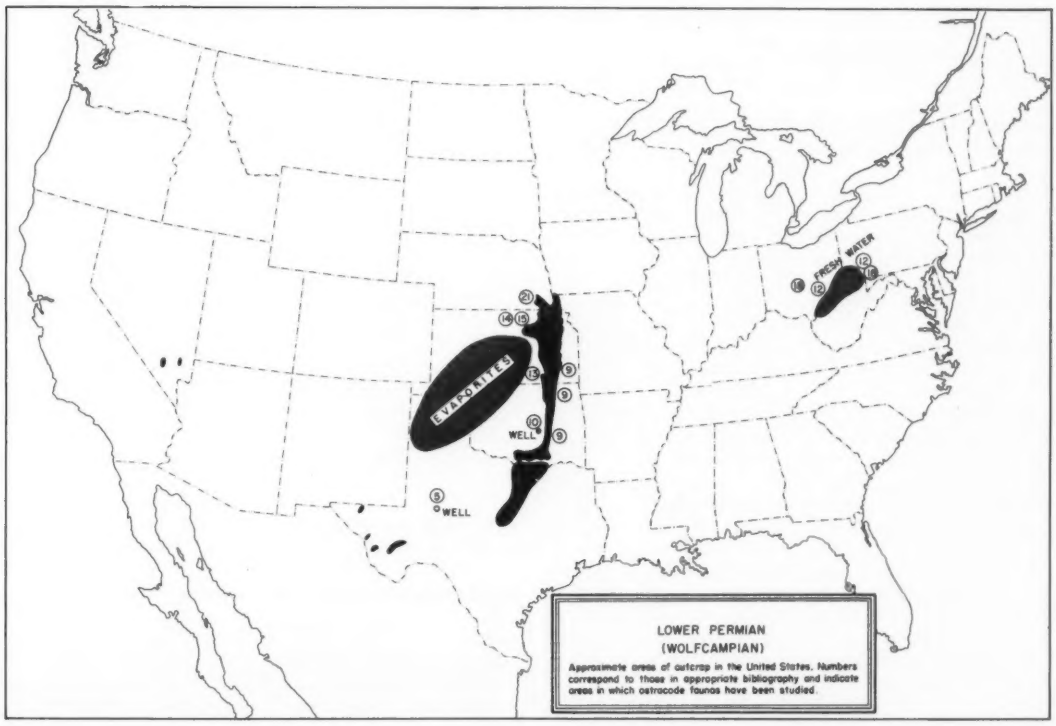
TEXT-FIGURE 6


WELL
WELL
UPPER PENNSYLVANIAN
(MISSOURIAN)
Approximate areas of outcrop in the United States. Numbers correspond to those in appropriate bibliography and indicate areas in which ostracode faunas have been studied.

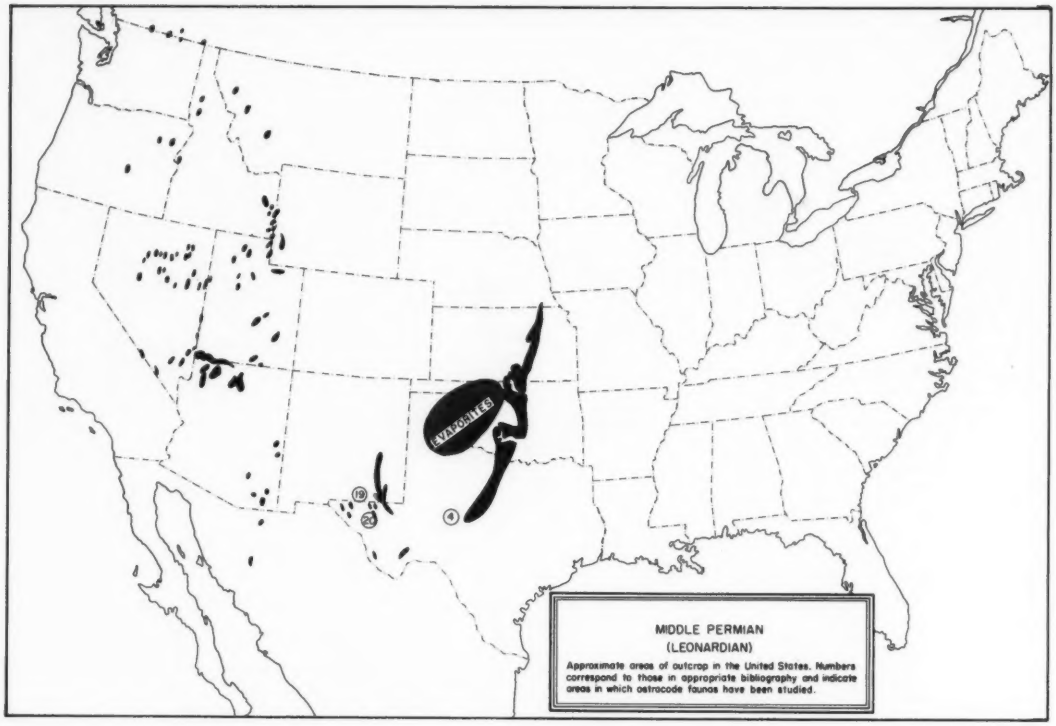
TEXT-FIGURE 7


WELL
UPPER PENNSYLVANIAN
(VIRGILIAN)
Approximate areas of outcrop in the United States. Numbers correspond to those in appropriate bibliography and indicate areas in which ostracode faunas have been studied.

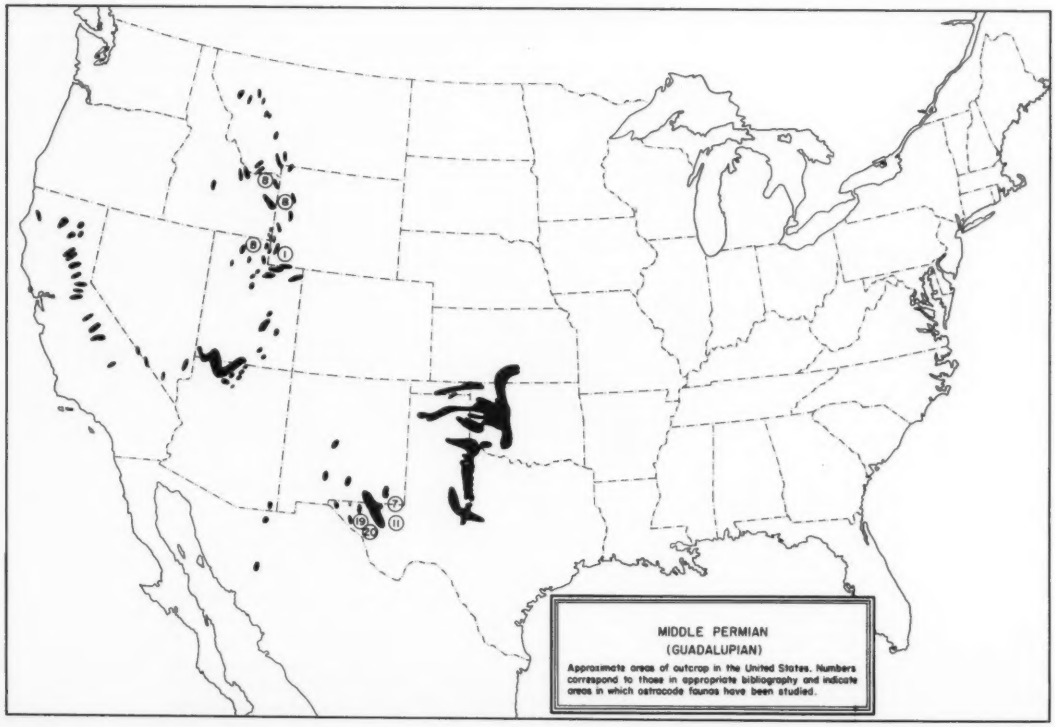
TEXT-FIGURE 8


FRESH WATER
EVAPORITES
WELL
WELL
LOWER PERMIAN
(WOLFCAMPIAN)
Approximate areas of outcrop in the United States. Numbers correspond to those in appropriate bibliography and indicate areas in which ostracode faunas have been studied.

TEXT-FIGURE 9


EVAPORITES
MIDDLE PERMIAN
(LEONARDIAN)
Approximate areas of outcrop in the United States. Numbers correspond to those in appropriate bibliography and indicate areas in which ostracode faunas have been studied.

TEXT-FIGURE 10


MIDDLE PERMIAN
(GUADALUPIAN)
Approximate areas of outcrop in the United States. Numbers correspond to those in appropriate bibliography and indicate areas in which ostracode faunas have been studied.

TEXT-FIGURE 11

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ABSTRACT: *In the region of the classic locality of Rosignano, the highly developed* Lepidocyclina (Nephrolepidina) tournoueri *is accompanied by* Miogypsina (Miogypsina) globulina. *The associated planktonics mainly consist of* Globoquadrina dehiscens *and* Globigerina globularis, *with scarcer* Globigerinoides triloba. *The Burdigalian a ge of this fauna shows the persistence of the Lepidocyclinidae in the Miocene of the Mediterranean area.*

Miocene foraminifera from Rosignano, northern Italy

C. W. DROOGER AND C. SOCIN
State University, Utrecht, and
Geological Institute, Turin

INTRODUCTION

In their paper of 1904, Lemoine and R. Douvillé recorded several *Lepidocyclina* species from the Italian locality Rosignano. Additional specific names were introduced by R. Douvillé (1908) and by Prever (1909).

The village of Rosignano lies in the northern hills of Monferrato, in the province of Alessandria, some 7 km. south-southwest of Casale and some 50 km. east of Turin. Geologically, this is the area of the Pietra da Cantoni, breccious limestones and marls with variable detailed stratigraphy. They overlie unconformably well-bedded marls of probable Oligocene and Eocene age (Elter, 1956). As may be seen from the geological map (Sacco, and Stella, 1924), the outcrops occur mainly in two adjoining anticlines, that of San Giorgio–Treville–Rosignano–Colma, and that of Sala–Moleto–Ottiglio (see text-fig. 1).

The microbreccious limestones occur in the lower part of the calcareous series. They are of variable thickness, up to 30 meters, and of variable composition. Algal balls are frequent, especially in the eastern part of the area. At some places they are of uniform size and embedded in clastic limestone with many serpentine grains. The latter mineral occurs in variable quantities throughout the series, including the overlying marls. These marls are more or less indurated, and are also of variable thickness. The total complex varies from about 40 to 80 meters.

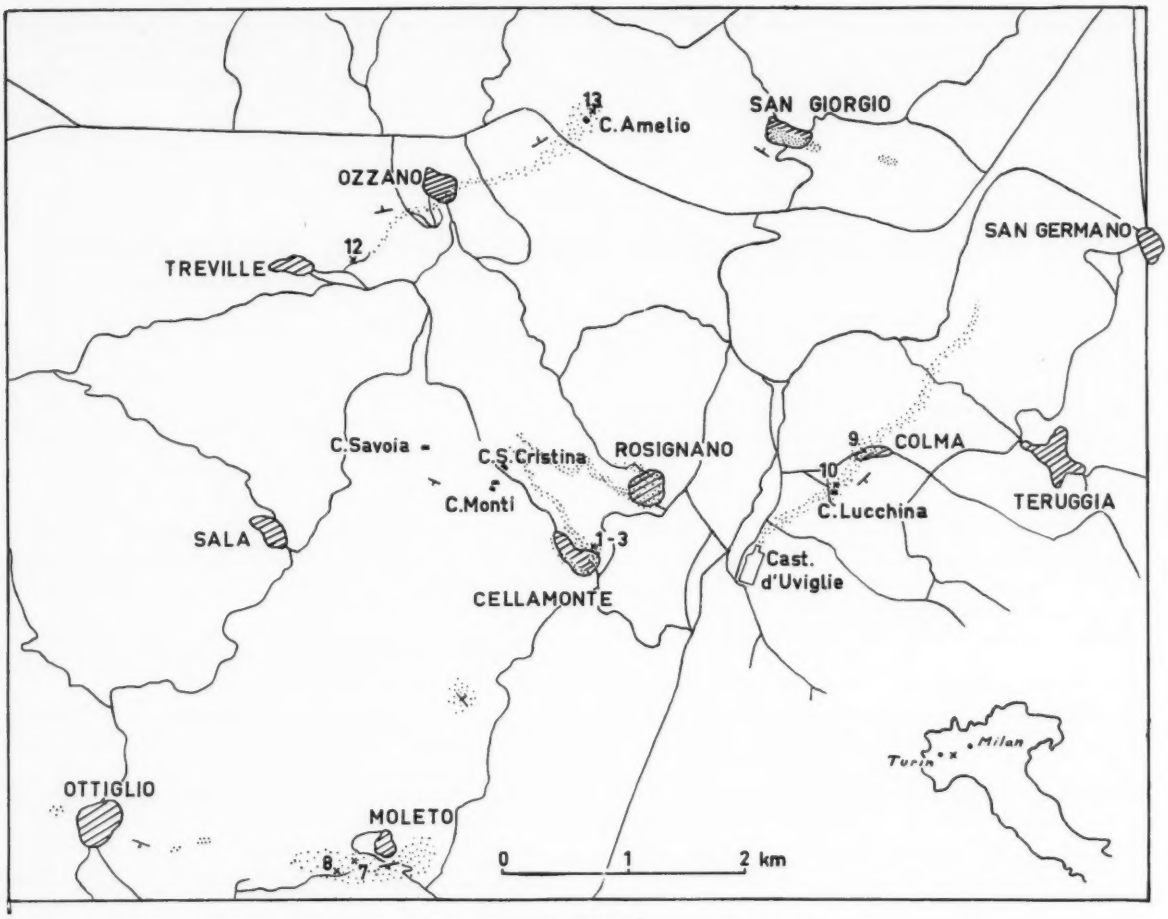
Concentrations of lepidocyclinids occur in the breccious limestones, commonly at a slight distance above the base. Higher up there are usually more miogypsinids. Planktonic and benthonic smaller foraminifera are most frequent in the overlying marls.

During several field trips, the authors collected samples at a number of localities. Further data were obtained from the field work of L. ter Berg (Utrecht) during the summer of 1958.

Samples containing numerous visible lepidocyclinids were collected at three places:

1) The abandoned quarry behind Villa Cosseto, Via della Torre, in the village of Cellamonte. Several samples were taken from a finely breccious limestone. The lepidocyclinids occur through a vertical distance of about three meters. They gradually decrease in number toward the top. Miogypsinids were found to increase inversely in number. Samples CM2, 1, and 3 were taken from the bottom to the top, respectively, at intervals of approximately one meter. Samples CM3a and 3b are from approximately the levels of samples CM1 and 2.
2) The quarry of Casa Lucchina. A sample (CM10) of breccious limestone with lepidocyclinids of variable size was taken in the western corner of this quarry in 1957, some five meters below a layer with numerous algal balls. This layer closely resembles that of Colma (CM9) (see below).
3) The abandoned quarry behind Casa Amelio on the road from Ozzano to San Giorgio. Samples CM13a and 13b are different samples from the same level, at a few meters from one another.

Some other samples appeared to contain only occasional Lepidocyclinas or none, but they yielded many more Miogypsinas. They were derived from probably the higher parts of the breccious limestones at the following localities:



TEXT-FIGURE 1

SKETCH MAP OF ROSIGNANO REGION SHOWING LOCATION OF SAMPLES

The main roads have been drawn in for orientation. In the dotted areas there are distinct outcrops of the microbreccious limestones of the Pietra da Cantoni.

4) A roadside outcrop at Colma di Rosignano. Sample CM9 was taken from a detrital limestone with much serpentine, which forms the matrix for numerous algal balls of uniform size (about 6 cm.).

5) Moleto, in the quarried hillside of this village at two places with unknown stratigraphic interrelations, but probably from the same or nearly the same level, in the upper part of the local breccious limestones with dispersed algal balls (samples CM7 and 8).

In addition, a number of samples of the marls were available. They are all from beds overlying the breccious limestones, but their stratigraphic interrelations are unknown.

6) Sample CM9b, from Bric Castello d'Uviglie, is probably the oldest.

7) Samples CM4b (Casa Monti), 4c (Casa Santa Cristina), and 4d (Casa Savoia) are all from the area west of Cellamonte.

8) Samples CM12 and 12a, from due west of the village of Treville, are from the area where the breccious limestones thin out. They are considered to be only slightly younger than the local breccious wedge.

Grateful acknowledgment is due to the Universities of Utrecht and Turin for their financial support of the field work. The authors further wish to thank J. E. van Hinte and J. P. de Zoeten (Utrecht), for their help in determining the smaller benthonic foraminifera, and L. J. A. ter Berg (Utrecht) for many of the field data. All specimens have been stored in the paleontological collections of the Mineralogical and Geological Institute of the State University of Utrecht.

LARGER FORAMINIFERA

In addition to the Lepidocyclinidae and Miogypsinidae, we found *Operculina complanata* (Defrance) as a rare constituent of the assemblages. Occasional individuals of *Gypsina* were encountered, especially in the samples from Moleto. Numerous fragments of *Sorites* were found, mainly in the samples with many Lepidocyclinas (CM2, 10, 13).

SYSTEMATIC DESCRIPTIONS

Family LEPIDOCYCLINIDAE Scheffen, 1932

Genus LEPIDOCYCLINA Gümbel, 1868

Subgenus NEPHROLEPIDINA H. Douvillé, 1911

Lepidocyclina (Nephrolepidina) tournoueri
Lemoine and R. Douvillé

Plate 1, figures 1–4; plate 2, figures 1–6; table 1

Lepidocyclina tournoueri LEMOINE AND R. DOUVILLÉ, 1904 (part), Mém. Soc. Geol. France, Pal., vol. 12, fasc. 2, no. 32, p. 19, pl. 1, fig. 5 (not pl. 2, figs. 2, 14; not pl. 3, fig. 1). – R. DOUVILLÉ, 1907, Bull. Soc. Géol. France, ser. 4, vol. 7, fasc. 1–2, pp. 54–56, text-fig. 7.

Not *Lepidocyclina tournoueri* Lemoine and R. Douvillé. – BRONNIMANN, 1940, Schweiz. Pal. Abh., vol. 63, pp. 47–54. – DROOGER AND MAGNÉ, 1959, Micropaleontology, vol. 5, p. 274.

Occurrence: Individuals are abundant in the samples from Cellamonte (CM2, 3a, 3b), C. Amelio (CM13a, 13b), and C. Lucchina (CM10).

External features: The specimens show considerable variation. Undamaged specimens from sample CM2 are circular in outline, equally to slightly unequally biconvex. The strongly inflated central part merges gradually into a distinct flange. The diameter of the test varies from 2 to 5 mm., the thickness from 1.0 to 2.2 mm. In sample CM3a the diameter is 2 to 8 mm., the thickness 1.2 to 2.5 mm. The surface of the flange is usually smooth, often showing the pattern of the underlying equatorial chambers. Toward the center the pustules gradually become more distinct, being situated at the meeting points of the vertical walls of three adjoining lateral chambers. Often there is an irregular meshwork of protruding vertical walls. Both pustules and meshwork generally become coarser toward the center of the test, where pustules may replace one or more columns of lateral chambers, so that there is a small number of larger pustules (diameter up to 400μ). There is great variation in these surface features. All kinds of intermediates are present between specimens that are completely smooth, others that are covered with meshwork, and still others with pustules all over. Pustulate individuals are predominant in samples CM2 and CM3a.

In sample CM10, most specimens have a diameter between 2 and 6 mm., and a thickness of 0.6 to 2.0 mm. Smaller and flatter specimens usually lack a distinct flange. The surface ornamentation often shows a polygonal meshwork.

Some large individuals in sample CM10, up to 20 mm. in diameter, are microspheric *Nephrolepidina* with a wide flange. In the literature they are generally referred to as *Lepidocyclina marginata* (Michelotti).

Some other large fragments, more or less saddle-shaped and without central pustules but with a meshwork of thick ridges, may belong to a different species. They appear to be microspheric; the equatorial chambers are arcuate to spatulate. Possibly they belong to *Lepidocyclina (Eulepidina) dilatata* (Michelotti), or to the equally indefinite *Lepidocyclina subdilatata* R. Douvillé (1908), originally described from Rosignano.

In sample CM13, most individuals are 1.3–3.5 mm. in diameter, with a thickness of 0.6 to 1.4 mm. Most of them are evenly inflated, a few have a more inflated central portion with a faint flange. Nearly all individuals have dominant meshworks at the surface, but the other types were encountered as well. In the center there are none to five larger pustules. Some large specimens, up to 7 mm., of the same external type, show a distinct flange and up to about twenty larger central pustules.

Sections: The flange usually was broken during the preparation of the material. Horizontal sections show that there was frequent damage and regeneration during life. Numerous crushed specimens, as well as vertical sections, show the lateral chambers with parallel roofs and floors. They are fairly distinctly arranged in columns. Chambers of each column communicate with those of adjacent tiers through stoloniferous apertures, which are clearly visible. The height of the lateral chambers is usually one-third to one-fifth of the length. The size of the elongate lumen of the chambers increases with the distance from the equatorial layer, and also in one layer from the periphery to the center of the test. The length of the lateral chambers exceeds that of the nearest equatorial chambers. The walls, roofs, and floors show numerous pores.

In horizontal sections the lateral chambers appear to be irregularly circular, with excess poreless material in the corners where three chambers meet. In the center of the test, this poreless material may have invaded the lumen of the chambers of some columns, causing larger pustules at the surface.

TABLE 1

MEASUREMENTS OF *Lepidocyclina tournoueri*

Locality and Sample number	N_1	N_2	Diameter I+II (μ) R	Diameter I+II (μ) $M \pm \sigma_M$	Diameter II (μ) R	Diameter II (μ) $M \pm \sigma_M$	Number of individuals with* 2	3	4	5	6	7	8	9	10	$M \pm \sigma_M$	Number of indiv. with 0	1	2
							AAC II										AAC I		
C. Lucchina, CM 10	42	27	450–900	584±15.2	450–750	594±13.0	1	3	3	5	5	6	3	1	–	5.69±0.34	21	–	1
Cellamonte, CM 3a	59	28	425–800	587±10.1	450–750	611± 9.4	–	–	4	6	7	8	2	–	1	6.11±0.27	14	–	–
Cellamonte, CM 3b	21	14	300–825	555±21.3	325–775	580±21.4	–	–	3	3	3	5	–	–	–	5.71±0.32	9	1	1
Cellamonte, CM 2	20	13	500–725	608±17.1	500–825	601±16.7	–	–	3	3	4	2	1	–	–	5.62±0.35	7	2	–
Cellamonte, CM 2+3a+3b	100	55		584		602	–	–	10	12	14	15	3	–	1	5.89±0.18	30	3	1
C. Amelio, CM 13a	25	21	350–600	480±12.2	350–650	513±13.3	–	–	3	9	5	2	2	–	–	5.60±0.26	14	2	–
C. Amelio, CM 13b	32	26	350–700	512±13.2	350–750	541±13.9	–	1	5	6	5	5	2	2	–	5.87±0.32	20	3	1
C. Amelio, CM 13a+b	57	47		498		529	–	1	8	15	10	7	4	2	–	5.74±0.21	34	5	1
Total		129					1	4	21	32	29	28	10	3	1	5.78±0.13	85	8	3

* In six specimens, no choice could be made between two successive values; in the table they have been given the value closest to the average.

TABLE 2

MEASUREMENTS OF *Miogypsina globulina*

Locality and Sample number	N	$200^{\alpha}/_{\beta}$ R	$200^{\alpha}/_{\beta}$ $M \pm \sigma_M$	γ° R	γ° M	Diameter I (μ) R	Diameter I (μ) M	M_{II}/M_I	Diameter test (mm.)	Thickness test (mm.)	Diameter pustules (μ)
Colma, CM 9	12	32–62	49±2.4	15–90	39	150–190	176*	1.39	0.9–2.2	0.5–1.0	25–100
Moleto, CM 8	13	19–88	38±5.0*	10–55	29*	150–200	178*	1.36	0.7–3.4	0.3–1.5	25–125
Moleto, CM 7	12	23–58	40±3.3*	10–50	24*	140–215	171*	1.30*	0.8–2.8	0.4–1.6	25–125
C. Lucchina, CM 10	10	21–62	40±3.9*	5–50	33*	135–210	172*	1.37	1.0–2.2	0.4–0.9	50–125
Cellamonte, CM 3	5	28–64	42 *	10–35	25*	150–185	165*	1.33*	0.8–2.0	0.5–1.0	75–150
Cellamonte, CM 1	10	22–44	32±1.8*	10–45	26*	125–190	155*	1.27*	1.0–1.6	0.5–0.9	50–170
Cellamonte, CM 2	3	24–39	32 *	5–40	18*	140–160	150*	1.44	1.0–2.0	0.5–1.0	25–125
C. Amelio, CM 13a	10	23–52	33±2.6*	–5–60	30*	135–185	165*	1.32*	0.8–2.4	0.3–1.0	30–125

* Mean values that are within the range of variation of those from Croce Berton, near Turin (see Drooger, 1954), are marked with an asterisk.

The vertical sections show that the height of the median layer increases considerably toward the periphery. Length and height of the individual chambers appear about equal. The embryonic chambers of megalospheric individuals protrude beyond the median layer. The wall between the protoconch and deuteroconch often deviates from the vertical, as much as 30°. These sections also show that the nepionic chambers are not all in the main layer of equatorial chambers, especially so on the protoconchal side. This accounts for the small percentage of horizontal sections that clearly show all nepionic chambers.

Numerous horizontal sections of the median layer demonstrate that this is a homogeneous group with no differences or only very slight differences between the samples. The large embryonic stage appears nearly circular in outline. It is of various nephrolepidine to "trybliolepidine" types. The outer wall is thick, sometimes showing traces of stolons and pores(?). The wall between the two chambers is thin and often partly absent. The dimensions of the embryonic chambers are somewhat smaller in sample CM13 than they are in the other samples.

The number of accessory auxiliary chambers is fairly high. There are two to ten of them on the deuteroconch. In 129 reliable sections from all our samples, the average number is 5.78. The calculated averages for the various samples were found to vary between 5.60 and 6.11. The differences between any two of these averages cannot be proved to have statistical significance. The auxiliary chambers are highly variable in length. Usually there is only a single interauxiliary chamber, a closing chamber, between any two of them. Symmetrical, somewhat longer nepionic spires are most common along the outer part of the protoconch. They consist of a variable number of chambers. A relatively small number of our sectioned individuals showed one or occasionally two accessory auxiliary chambers on the protoconch.

The equatorial chambers are of fairly uniform shape. They are arcuate to arcuate-ogival near the center, and ogival-spatuliform or even rounded hexagonal toward the periphery. A cyclic arrangement is predominant throughout. Basal annular stolons are sometimes visible, but all efforts to find diagonal stolons failed. Black lines in the walls of the later equatorial chambers, as described by Tan Sin Hok (1934, p. 205), are clearly visible in our material, but their origin is not fully understood.

Remarks: Van der Vlerk (1957, p. 25) has recently demonstrated that it is very likely that the Mediterranean species of *Nephrolepidina* all belong to a single group. For the differentiation of the species, we consider the number and arrangement of the accessory auxiliary chambers to be the primary features, combined with the shape of the embryonic chambers and the shape and arrangement of the equatorial chambers. In these respects our assemblages differ from most of the better-known occurrences in the western Mediterranean area, in that they have high average numbers of auxiliary chambers, combined with nephro- to trybliolepidine types of embryonic chambers, and equatorial chambers arranged mainly in circles. They are comparable with certain species of the Far East, such as *Lepidocyclina rutteni* van der Vlerk.

The only definite report of very similar individuals was that of *Lepidocyclina (Trybliolepidina) renzi* (David-Sylvain) from Morocco by Bronnimann (1940, p. 57, pl. 6, fig. 9). *Amphilepidina renzi* David-Sylvain (1937, p. 18, pl. 2, fig. 2), from Sicily, also probably belongs here, but the figure does not permit a definite conclusion.

Nomenclature: It appears that the specific name of our species must be *Lepidocyclina tournoueri*. Originally described by Lemoine and R. Douvillé as one of their smaller *Nephrolepidina* species, it was considered to differ only in ornamentation from *Lepidocyclina morgani* Lemoine and R. Douvillé (1904) and *Lepidocyclina aquitaniae* Silvestri (1912) (= *L. simplex* H. Douvillé, 1925). These species have been reported from several localities in France, Spain, Italy, and North Africa. In later years, *Lepidocyclina tournoueri* has generally been accepted as the specific name for the entire group.

TABLE 1

N_1 = number of specimens corresponding to the diameter columns. N_2 = number of specimens corresponding to the AAC II columns. The diameters of the embryonic chambers include half the walls; those of I + II were measured through the centers of the embryonic chambers, and those of II at right angles. AAC II = accessory auxiliary chambers on the deuteroconch. AAC I = accessory auxiliary chambers on the protoconch. R = range; M = mean.

TABLE 2

N = number of sectioned individuals. $200^{\alpha}/_{\beta}$ = the degree of symmetry of the protoconchal nepionic spires. γ = the angle between the axis of the two embryonic chambers and the apical-frontal line. M_{II} and M_I = the mean values of the diameters of the deuteroconch and protoconch, respectively. R = range; M = mean.

Bronnimann (1940) described the variation in the internal features of *Lepidocyclina tournoueri* in his Moroccan material. He applied the name to specimens with a nephrolepidine embryonic stage and with two to six accessory auxiliary chambers on the deuteroconch (average about 3.5), and with only occasionally one or two such chambers on the protoconch. This interpretation was followed by Drooger in several publications on associations from southwestern France, northern Italy, Spain and Algeria (1959), including those from several localities of earlier authors.

However, Lemoine and R. Douvillé, in a note appended to their manuscript and preceding the plates, stated that the type figures of their new species are those of the vertical sections. Unfortunately, the specimen of the only vertical section of *Lepidocyclina tournoueri* (Lemoine and R. Douvillé, 1904, pl. 1, fig. 5) was from Rosignano, and it is the only vertical section from that locality. Henri Douvillé later (1925, p. 79) declared that the type of this species should be taken from among the material from Baèna, Spain, but this selection cannot be accepted.

The exact type locality of *Lepidocyclina tournoueri* cannot be fixed. Rosignano evidently stands for the environs of this village, including Colma, Lucchina, and probably Cellamonte. In the village of Rosignano itself we did not find outcrops with numerous lepidocyclinids, but conditions may have changed during the past fifty years. There is no doubt, however, about the identity of the species, as it appeared from the field work that we are dealing with only one possible stratigraphic level, that containing our highly developed Lepidocyclinidae. Moreover, the published vertical section of Lemoine and R. Douvillé very closely resembles ours. We do not, of course, distinguish differently ornamented types as separate species.

This change in the concept of *Lepidocyclina tournoueri* leaves us with the problem of the specific name that should replace *Lepidocyclina* "*tournoueri*" of authors, i.e., in the sense of Bronnimann. This species is common at a lower stratigraphic level. *Lepidocyclina morgani* Lemoine and R. Douvillé (1904) is probably the correct name. Its type locality is the Pont du Guadalquivir in Spain.

Family Miogypsinidae Tan Sin Hok, 1936

Genus Miogypsina Sacco, 1893

Subgenus Miogypsina Sacco, 1893

Miogypsina (Miogypsina) globulina (Michelotti)

Plate 1, figures 5–6; table 2

Nummulina globulina Michelotti, 1841, Mem. Soc. Ital. Sci. Modena, vol. 22, p. 297, pl. 3, fig. 6.

Miogypsina globulina (Michelotti). – Schlumberger, 1900, Bull. Soc. Géol. France, ser. 3, vol. 28, p. 329, pl. 2, fig. 8.

Nummulites irregularis Michelotti (not Deshayes, 1838), 1841, Mem. Soc. Ital. Sci. Modena, vol. 22, p. 296, pl. 3, fig. 5.

Miogypsina irregularis (Michelotti). – Schlumberger, 1900, Bull. Soc. Géol. France, ser. 3, vol. 28, p. 328, pl. 2, figs. 1–7, 9–10; pl. 3, fig. 17. – Bronnimann, 1940, Schweiz. Pal. Abh., vol. 63, p. 88, pl. 8, figs. 1–11; pl. 10, figs. 6–11; pl. 11, figs. 1, 4. – Drooger, 1952, Study Amer. Miogyps., p. 54, pl. 2, figs. 25–29. – Drooger, 1954, Proc. K. Nederl. Akad. Wetensch., ser. B, vol. 57, p. 238, pl. 2, figs. 1–5. – Drooger, 1955, Verh. K. Nederl. Akad. Wetensch., ser. 1, vol. 21, no. 2, p. 24, pl. 1, figs. 6–10.

Nomenclature: *Nummulites irregularis* Michelotti is a homonym of *Nummulites irregularis* Deshayes. Therefore, the name *Miogypsina irregularis*, widely used since Schlumberger's paper (1900), should be dropped. Most later authors, including ourselves, have neglected to do so, or the fact simply escaped their attention. Since it is generally accepted that the two *Miogypsina* species described by Michelotti (1841) are identical, *Miogypsina globulina* is the correct name. The original material being lost, the neotype of *Miogypsina globulina* is the specimen of *Miogypsina irregularis* from Croce Berton (Drooger, 1954, p. 239), in the Utrecht collections, no. S337.

Occurrence: The species is abundant in the samples from Moleto (CM7, 8), fairly frequent to rare in those from Colma (CM9), Cellamonte (CM1, 2, 3), C. Amelio (CM13), and C. Lucchina (CM10).

Remarks: Both externally and internally the individuals form a homogeneous group, in which the differences between the various samples are only slight. The individuals are of small to moderate size, those from Moleto being the largest, up to 3.4 mm. The relative thickness is variable, usually high and about half the diameter. The thickest part is situated excentrically. The outline is more or less circular, with a distinct apical portion, which is often somewhat protruding. The distinct pustules are evenly scattered, generally of fairly constant diameter in any one individual. The specimens from C. Amelio are the thinnest, and those from Moleto the thickest, occasionally with traces of a flange near the periphery.

The data in Table 2 show the slight differences in the internal characters between the various samples. From the average values of 200 α/β it appears that the entire group represents a highly developed form of *Miogypsina globulina*, transitional to *Miogypsina intermedia* Drooger. The higher values of $M_{200\alpha/\beta}$ and M_I are found in the samples without Lepidocyclinas, except for that from C. Lucchina (CM10). The differences between the M_γ and M_{II}/M_I values are slight; their correlation with $M_{200\alpha/\beta}$ values seems to be insignificant. Our samples are evidently very close to one another stratigraphically, too close to show distinct nepionic acceleration. The observed tendencies agree with our ideas concerning the relative stratigraphic positions of the samples.

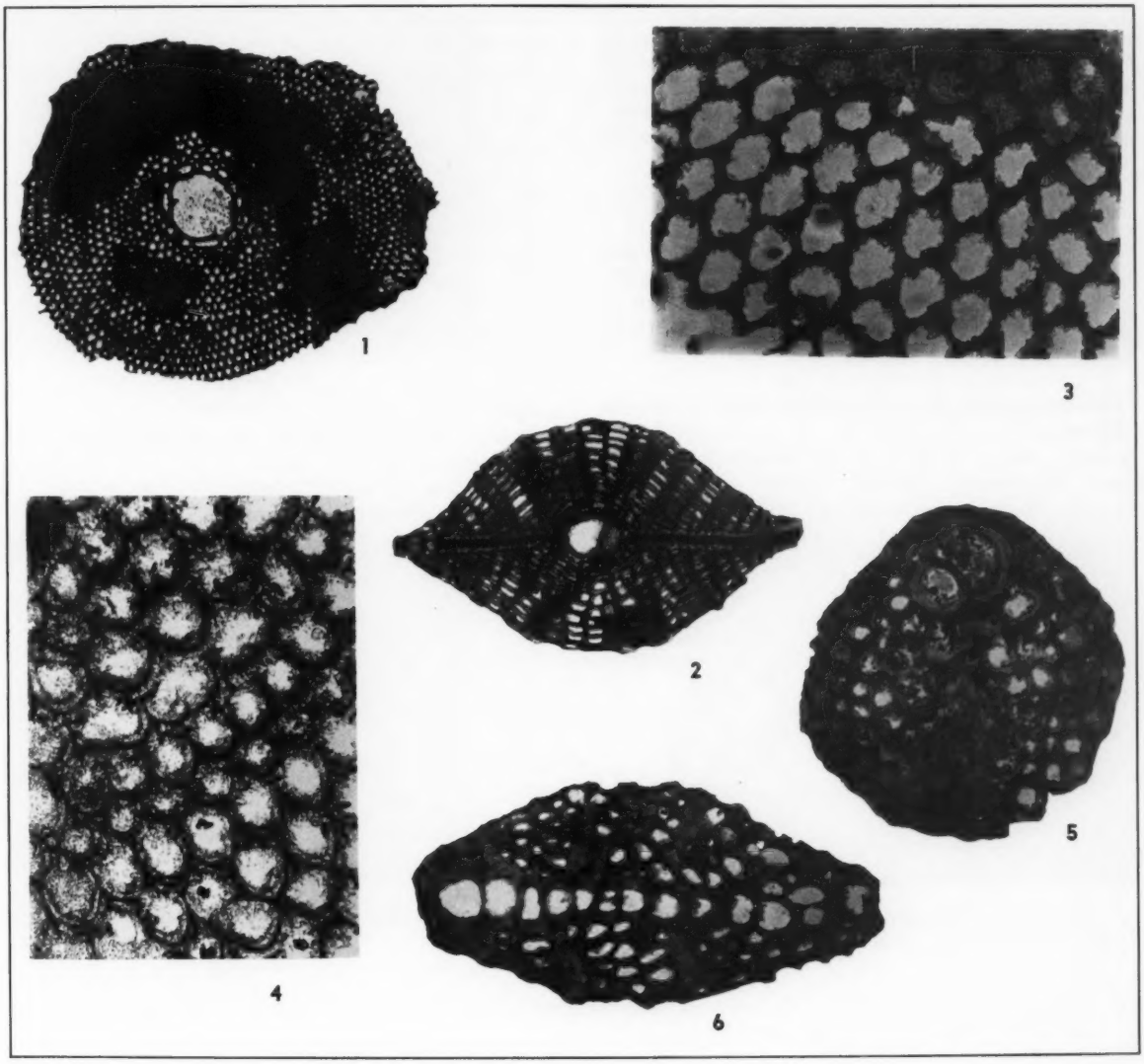


PLATE 1

1–4 *Lepidocyclina tournoueri* Lemoine and R. Douvillé
1, horizontal section, × 16, of specimen 1–1, sample CM10, C. Lucchina, showing the cyclic arrangement of the equatorial chambers; 2, vertical section, × 16, of specimen d1–2, sample CM2, Cellamonte; 3, horizontal section, × 115, of part of the median layer of specimen 12–1, sample CM10, C. Lucchina; 4, horizontal section, × 115, of part of the median layer of specimen 4–1, sample CM10, C. Lucchina; figs. 3–4 show the ogival to spatulate shape of the equatorial chambers; the pores of the roof are very clear in the upper part of fig. 3; the black lines and the inner and outer calcite layers are visible in both; basal annular stolons are frequently indicated, but diagonal stolons are not apparent; at the place where they might be expected, there are sometimes dark lines that seem to belong to the system of black lines; they occur close to roofs and floors especially.

5–6 *Miogypsina globulina* (Michelotti)
5, horizontal section, × 50, of specimen 6, sample CM10, C. Lucchina; 6, vertical section, × 50, of a specimen from sample CM8, Moleto.

In many details, our miogypsinids from the Rosignano area resemble assemblages of the same species from the hills of Turin (Drooger, 1954). The averages that fall within the range of variation of the Turinese samples are marked with an asterisk in Table 2. This resemblance suggests a close connection between the populations of the two areas.

BENTHONIC SMALLER FORAMINIFERA

The benthonic associations of a number of samples (CM2, 4b, 4c, 4d, 7, 8, 9, 12, 12a) were carefully analyzed by J. P. de Zoeten and J. E. van Hinte. In order to facilitate correlation, they used primarily the literature of Italian authors.

The samples from the breccious limestones are clearly different from the others in the small number of species, with predominance of *Cibicides pseudoungerianus* (Cushman), *Cibicides lobatulus* (Walker and Jacob), *Amphistegina lessonii* d'Orbigny, *Asterigerina planorbis* d'Orbigny, and *Elphidium crispum* (Linné). Miliolidae are very rare or absent. The associations point to "fore-reef" conditions.

The fauna of the marls is much more heterogeneous, with variable high quantiies of the more common species, which are listed below:

Spiroplectammina wrighti (Silvestri)
Vulvulina pennatula (Batsch)
Lenticulina spp.
Marginulina hirsuta d'Orbigny
Guttulina problema (d'Orbigny)
Glandulina aequalis Reuss
Nonion pompilioides (Fichtel and Moll)
Plectofrondicularia diversicostata (Neugeboren)
Bulimina pupoides d'Orbigny
Bolivina scalprata Schwager var. *miocenica* Macfadyen
Bolivina arta Macfadyen
Uvigerina flinti Cushman
Uvigerina gallowayi Cushman
Uvigerina proboscidea Schwager
Siphonodosaria verneuili (d'Orbigny)
Siphonodosaria adolphina (d'Orbigny)
Eponides "haidingeri" (of Brady, not d'Orbigny)
Gyroidina soldanii d'Orbigny
Sphaeroidina bulloides d'Orbigny
Hanzawaia boueana (d'Orbigny)
Cibicides lobatulus (Walker and Jacob).

The very peculiar form *Virgulinella pertusa* (Reuss) was found only in the Treville samples.

Comparison of the total fauna of about 130 identified species with the tables published by AGIP (1957)

PLATE 2

All figures of *Lepidocyclina tournoueri* Lemoine and R. Douvillé; horizontal sections of embryonic and periembryonic (nepionic) chambers, × 60.

1 Specimen 1–1, sample CM3b, Cellamonte; there are seven accessory auxiliary chambers (AAC) on the deuteroconch (II), and two on the protoconch (I).

2 Specimen 3–4, sample CM3b, Cellamonte; seven (or eight) AAC on II, possibly one on I.

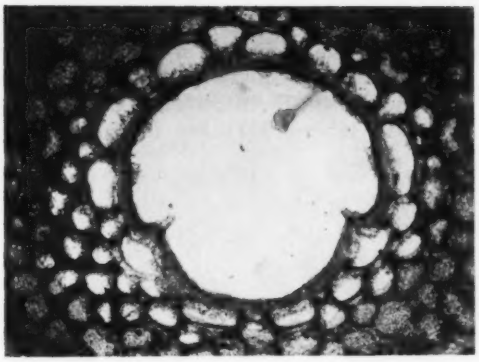
3 Specimen 2–4, sample CM10, C. Lucchina; six AAC on II, symmetrical spires on I; the auxiliary chambers are of different lengths.

4 Specimen 1–1, sample CM10, C. Lucchina; seven AAC on II, symmetrical spires on I.

5 Specimen 2–1, sample CM10, C. Lucchina; nine AAC on II, probably long symmetrical spires on I.

6 Specimen 5–3, sample CM10, C. Lucchina; three elongate AAC on II; the spires on I consist only of long primary auxiliary chambers and a closing chamber.

The pores of the roofs and floors of the equatorial chambers are clearly visible in figures 3 and 6. The coating of all cavity walls with tiny calcite crystals is also apparent. Basal stolons are frequently visible, among others those of the deuteroconch in figures 1 and 5. Black lines within the walls are most distinct in figure 3.



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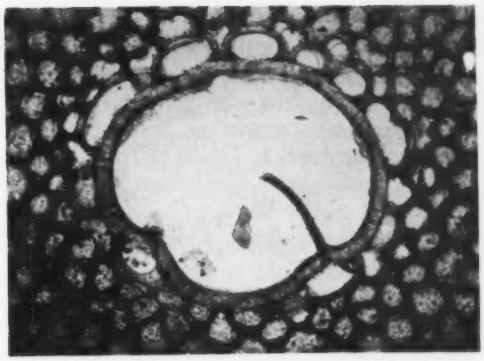

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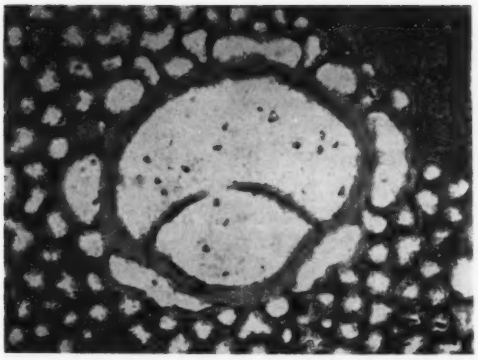

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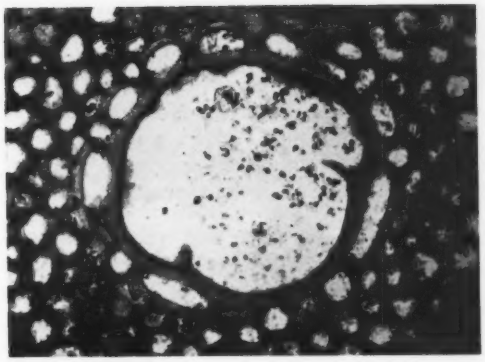

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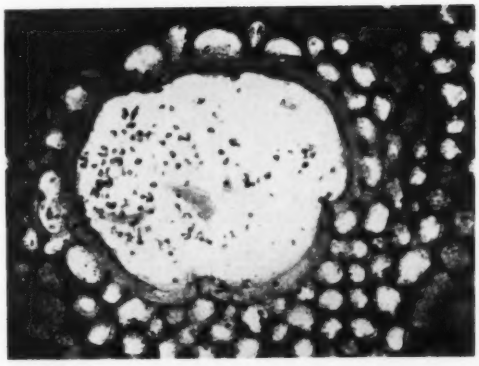

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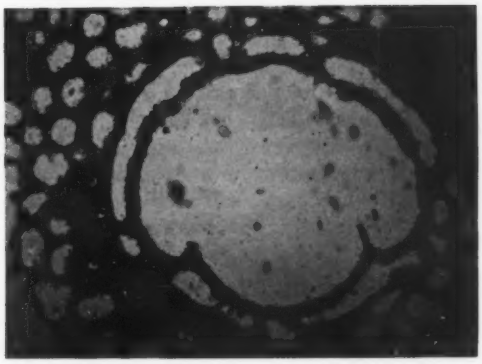

6

indicated the closest correlation with the "Elveziano–Tortoniano". In the area near Tortona (Gianotti and Ruscelli, 1953), there is even better correlation with the Tortonian than with the "Elveziano". This is probably a reflection of the close facies resemblance between our marls and those of Tortona, rather than of their similar ages. In addition, there is reasonable agreement of our fauna with those of the Miocene of Egypt (Macfadyen, 1930) and of the Vienna Basin (Marks, 1951).

PLANKTONIC FORAMINIFERA

Some of the samples with larger foraminifera, such as sample CM9, contained numerous distinct *Globoquadrina* specimens of the types of *Globoquadrina dehiscens* (Chapman, Parr and Collins) and *Globoquadrina quadraria* (Cushman and Ellisor). *Globigerinoides triloba* (Reuss) is usually present, but it is less frequent than the group of *Globigerina globularis* Roemer, which is highly variable, with variants resembling *Globigerina ampliapertura* Bolli and *Globigerina* cf. *trilocularis* Bolli, and approaching the types of *Globigerina bulloides* d'Orbigny, *Globigerina concinna* Reuss, and *Globigerina venezuelana* Hedberg. *Globigerina mayeri* (Cushman and Ellisor) is another constituent, and small specimens resembling *Globigerina ciperoensis* Bolli were observed repeatedly.

Planktonics are more numerous in the overlying marls. The same types recur more or less distinctly and in somewhat variable quantities, but there is no fundamental difference. Representatives of *Globigerinoides* are nearly always present, but they are distinctly less numerous than *Globigerina* and *Globoquadrina* together. *Globigerina dissimilis* (Cushman and Bermudez) is very rare and indistinct, but *Globigerina unicava* (Bolli) is more common. *Orbulina* and *Globigerinoides bispherica* Todd were not encountered. One sample (CM4d), from an unknown stratigraphic level in the marls, contained some very small specimens of true *Globorotalia*, which resemble *Globorotalia scitula* (d'Orbigny).

These associations do not correspond well with the tables of AGIP (1957) or of Bolli (1957). Differences in identifications may be partly responsible. Comparison is probably hampered also by regional variations, such as those caused by temperature differences. Moreover, short-distance differences of unknown origin must be expected.

With regard to Bolli's Trinidad succession (1957), and allowing for some extension of the ranges of individual species, correlation with the former *Globigerina dissimilis* zone (= *G. kugleri* to *G. stainforthi* zones of 1957) is most plausible. The same conclusion can be drawn from Drooger's tentative table (1956) for the western Mediterranean area, in which this zone was assigned an Aquitanian-Helvetian range. It is even more difficult to correlate our samples with the AGIP table (1957), but the bulk of our assemblage seems to correspond to their "Aquitaniano–Langhiano." From the older table of Di Napoli (1952), we reach the same conclusion. More satisfactory correlation can be obtained with Selli's threefold subdivision in southern Italy (1957, pp. 32–33). We are evidently dealing with his lower *Globoquadrina* zone, in which he found *Miogypsina irregularis* (= *M. globulina*).

AGE

Earlier age determinations of the Pietra da Cantoni range from Aquitanian to Helvetian, the average being identical with our conclusions. They were based mainly on the presence, or the external features, of the Lepidocyclinae, or on macrofossils such as *Clypeaster*. Miogypsinids were never seriously considered.

The Miogypsinidae indicate that the breccious limestones were deposited during a relatively short interval corresponding to part of the Burdigalian. *Miogypsina globulina* (= *M. irregularis*) and *Miogypsina intermedia* are the Burdigalian species of the *Miogypsina* sequence in the typical deposits of this age near Bordeaux. The same species, with closely similar assemblages, were encountered in the hills of Turin, at Croce Berton.

On the basis of the principle of nepionic acceleration, our *Lepidocyclina tournoueri* from Rosignano is more highly developed than the *Lepidocyclina* species from the classic locality near Turin (Villa Sacco). That species is *Lepidocyclina morgani*, and is accompanied by *Miogypsina complanata* Schlumberger. The same association is found at the long-known localities with pre-Aquitanian sediments in the Aquitaine basin, such as Saint-Géours and Saint-Etienne-d'Orthe. In future we shall possibly be able to recognize intermediate *Nephrolepidina* assemblages of Aquitanian age. However, the average number of accessory auxiliary chambers probably depends on more factors than geologic age alone, so that too narrow subdivision on this basis may be dangerous. The probable occurrence of a species of *Eulepidina* in the Burdigalian would extend the stratigraphic range of that subgenus in Europe.

The planktonic association does not contradict the Burdigalian age determination of the sediments. Although it is a negative argument, the absence of *Orbulina* is important, again pointing to a post-

Burdigalian beginning for this genus. Whether it began in the early Helvetian (Selli, 1957) or in the early Tortonian (Drooger, Papp and Socin, 1957) cannot be decided in this area.

The benthonic associations are of little use for more exact age determination. Even on the regional scale of the north Italian basin, the marly character of the sediments produces an age determination (Tortonian) that conflicts with the evidence of the larger foraminifera and the planktonics. No doubt these associations have a much longer stratigraphic range.

ECOLOGY

Most remarkable is the association of *Miogypsina globulina* with numerous Lepidocyclinas at one locality (Rosignano) and not at the other (near Turin), which are separated by a distance of only 50 km. Age differences are regarded as a very unlikely explanation. A difference of environment would be more plausible. Near Turin the miogypsinids were found in clastic inorganic sediments of deltaic origin, whereas in the Rosignano area, they occur in calcareous debris of fore-reef facies. In the latter area, transportation from the hinterland was slight, the water was cleaner and possibly subject to less fluctuation in salinity. The difference in the sedimentary environments may have prevented the Lepidocyclinas from entering the more westerly parts of the coastal section of the Piemonte basin.

One might also assume that the two species of larger foraminifera preferred somewhat different environments in relation to the "reefs." Actually, *Sorites* fragments accompany our *Lepdocyclina tournoueri* in much greater abundance than they do our *Miogypsina globulina*. This would mean that *Lepidocyclina tournoueri* occupied an area situated more toward the back of the reef. Miliolidae are absent, however, and the *Sorites* are very fragmentary. They probably suffered considerable transportation, and probably lived in different areas from the Lepidocyclinas. The assumption that lepidocyclinids lived more toward the back of reefs also conflicts with van Bellen's statement (1956, p. 255) that miogypsinids *(Miogypsina complanata)* ranged farther into the back-reef area than lepidocyclinids. But of course there is no need to assume that the environments of these groups were always and everywhere the same. As a result, environmental factors may have played a role in northern Italy, but they do not account clearly for the peculiar distribution of the Lepidocyclinidae, the more so because the field work showed that the "reef" pattern in our area was probably a complicated one, connected with differential movements of the Miocene sea-bottom.

A more regional explanation may also be advanced, in which the geographic distribution of *Lepidocyclina tournoueri* found its limit between Turin and Rosignano more or less accidentally. Lepidocyclinas of undoubtedly Aquitanian age, i.e., contemporaneous with *Miogypsina gunteri* and *Miogypsina tani*, are as yet unknown in the western Mediterranean area. Possibly the group died out with the late Oligocene *Lepidocyclina morgani*, and later populations of this stock reinvaded the area from the east during the Burdigalian. In this connection, the frequent association of *Miogypsina globulina* and *Nephrolepidina* reported by Selli in southern Italy thus becomes more comprehensible. The Burdigalian, with its general transgression in our part of the world, permitted this invasion, just as it enabled *Miogypsina burdigalensis* to spread from its Turin habitat over the entire western Mediterranean area.

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ABSTRACT: *The Crug limestone was deposited during an interval in terrigenous sedimentation, hence the rich conodont fauna. The conodonts are comparable with other roughly contemporaneous Welsh faunas and with the Keisley limestone fauna, which is also, possibly, to some extent Caradocian. Among the fauna described are six new species. One asymmetrical* Ozarkodina *has only "right" specimens. The status of* Prioniodina– *and* Cordylodus–*like genera is discussed.*

Conodonts from the Crug limestone (Ordovician, Wales)

MAURITS LINDSTRÖM
University of Lund
Sweden

INTRODUCTION

The type locality of the Ordivician (Caradocian) Crug limestone is a quarried outcrop at Crug Farm, about one-half mile north of Llandeilo, in Carmarthenshire, Wales. For further particulars concerning the locality and its geologic setting, see Williams (1953).

On visiting the classic Llandeilo district in 1956, I took a sample at this locality, and later on searched the sample (sample 1956) for conodonts. As it was very easy to digest the limestone in dilute acetic acid, and as it yielded a conodont fauna that was unusual for these districts in its abundance and also, to some extent, in its character, I found it worth while to investigate the faunule, especially as I was encouraged to do so by Professor Frank Rhodes, to whom we owe the works on Welsh Ordovician conodonts that have been published so far. Further material (samples 1–5) of the Crug limestone was collected in 1957. On that occasion Professor Rhodes showed me his hospitality at Swansea.

Thanks to a grant from the Faculty of Sciences of the University of Lund, I had an opportunity, in 1956, to see the Rhodes collections of conodonts at Birmingham and Durham and at the Geological Survey, in London. For their kindness on this occasion I am especially indebted to Dr. F. W. Anderson and Mr. J. D. D. Smith, of London, and to Professor F. W. Shotton and Dr. I. Strachan, of Birmingham.

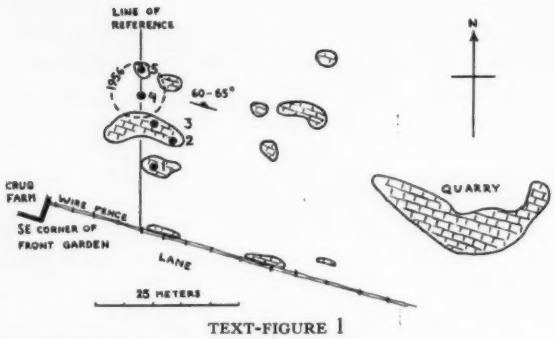
STRATIGRAPHIC REMARKS

Ordovician conodonts have been found at the following stratigraphic levels in Britain, in ascending sequence: Lower Arenigian (chert shales in the Southern Uplands of Scotland; Lamont and Lindström, 1957); lower Llandeilian (Llandeilo limestone of the Llandeilo district; Rhodes, 1953); upper Llandeilian and basal Caradocian (chert shales in southern Scotland; Lamont and Lindström, 1957); middle Caradocian (*Climacograptus wilsoni* shale of southern Scotland; Lindström, 1957); middle and upper Caradocian (Gelli-grin and Pen-y-garnedd limestones of northern Wales; Rhodes, 1953); and Ashgillian(?) (see the discussion below) (Keisley limestone of Westmorland; Rhodes, 1955).

The Crug limestone, according to Williams (1953), is probably equivalent to the upper Longville flags of the Welsh Borderland. These flags belong to the Marshbrookian stage of Bancroft (i.a., 1933), which, according to Dean (1958), is the middle one of five stages probably equivalent to the graptolite zone of *Dicranograptus clingani*, i.e., middle upper Caradocian It will thus be of interest to determine the age relationship between the Crug limestone, on the one hand, and the Gelli-grin and Pen-y-garnedd limestones of Rhodes (1953) on the other, as the latter two limestones are also middle or upper Caradocian. I shall therefore rely on information already published, although I know that this information may possibly be out of date rather soon.

According to Bancroft (1933), the Gelli-grin limestone of the Bala area may correspond to the upper part of the lower Longvillian or the lower part of the upper Longvillian of the Welsh Borderland. Now, the Longvillian stages occupy a position below the Marshbrookian. The Crug limestone being possibly Marshbrookian, one may perhaps assume that it is younger than the Gelli-grin and probably also than the Pen-y-garnedd limestone.

I cannot make any very useful correlations with possibly corresponding strata in North America on the basis of what has been published. The vertical ranges of the conodont genera found in the Crug



TEXT-FIGURE 1

Crude sketch of the locality at Crug Farm near Llandeilo, Carmarthenshire, Wales. Outcrops of bare rock indicated. Location of samples 1–5 shown by large dots and numerals. Approximate location of sample 1956 shown by broken circlet.

limestone are not very helpful, first because their vertical ranges as already known are fairly wide, and secondly because one can be sure that the real vertical ranges of conodont genera are far from sufficiently known. Some characteristic elements seem to be shared with the following formations in North America: The Kimmswick limestone of Missouri (Mehl and Strothman, in Branson, 1944) (*Prioniodina pulcherrima* n. sp.); the Maquoketa-Thebes of Missouri (Branson and Mehl, 1933) (*Ambalodus triangularis*); the Maquoketa formation of Iowa (Glenister, 1957) (probably *Ambalodus triangularis*); and the Maravillas chert of Texas (Graves and Ellison, 1941) (*Ambalodus triangularis*).

SAMPLES

Six samples were taken at the Crug Farm locality. Samples 1–5 were taken along a measured reference line that was chosen so that it ran northward from a big post of the wire fence 16.5 meters east of the southeast corner of the front garden of Crug Farm.

Sample 1: 11.0 meters north of fence, about 3 meters east of this point on the reference line. Somewhat brecciated outcrop of coarse, dark-gray limestone poor in macrofossils. Sample taken in middle of least brecciated, west-northwestern part of outcrop.

Sample 2: 16.4 meters north of fence, on line of strike of bed cutting reference line at this point, in eastern part of outcrop. Light-gray limestone bed with small phosphorite pebbles at base.

Sample 3: 18.9 meters north of fence. Phosphorite conglomerate with coarsely crystalline gray limestone as matrix.

Sample 4: 23.0 meters north of fence. Rather massive gray limestone.

Sample 5: 27.8 meters north of fence. Gray limestone, rather rich in macrofossils and phosphorite grains.

Sample 1956: Taken in the northern part of the locality.

OCCURRENCE OF THE CONODONTS

The Crug limestone is uniformly composed of dark-gray, relatively pure limestone with grains and small nodules of phosphorite, which are especially concentrated in some layers. The dark-gray colour may be due in part to abundant microscopic spherules, probably of pyrite, which also occurs as small crystal aggregates. Some argillaceous material is also dispersed in the limestone. There are relatively sparse angular sand grains of quartz, among which are a few bipyramidal crystals without the prisms. The calcium carbonate occurs mostly as monocrystalline rounded sand and silt particles of pure calcite, which stand out especially clearly where the matrix is argillaceous. In calcitic matrix, the silt particles do not appear. More or less abraded fragments of echinoderms, arthropods, and bryozoans contribute to the sand fraction of the sediment. As mentioned by Williams (1953), the rock also yields determinable macrofossils, principally brachiopods.

Apart from the conodonts, scolecodonts are by far the most abundant microfossils in the residues of the limestone after digestion in acetic acid. Conodonts are the most abundant in the lower parts of the limestone, and decrease in frequency upward, as will appear from the following data:

Sample 1: 1.5 kg. of rock digested; 35 conodonts per 0.1 kg of rock.

Sample 2: 0.4 kg. digested; 12 conodonts per 0.1 kg.

Sample 3: 0.8 kg. digested; 4.5 conodonts per 0.1 kg.

Sample 4: 0.8 kg. digested; 5 conodonts per 0.1 kg.

Sample 5: 1.4 kg. digested; 1 conodont per 0.1 kg.

The conodonts appear to be strongly corroded and are most fragmentary in the upper part. This picture of gradual diminution and deterioration of the conodont fauna from bottom to top of the limestone is disturbed by the fact that sample 1956 contains a faunule that is both rich and well preserved, although probably not as rich in individuals as that of samples 1 and 2 (the amount of limestone digested out of sample 1956 was not recorded).

The Crug limestone is characterized by the great scarcity of terrigenous non-carbonate sediment. In this respect it marks a radical change from older sediments. The underlying Llandeilian and lower Caradocian, according to Williams, consist of at least 3400 feet (1040 meters) of shales, sandy flags, and

impure limestones. That this is a really thick pile of terrigenous sediments can be judged from a comparison with Sweden, where the corresponding sequence seemingly may be 40–60 meters, at the most, over large areas.

Evidently the carbonate sediment came from eroded deposits of largely organogenic calcium carbonate. The particles may not have been transported very far. The distribution and preservation of the conodonts suggest that they may all have come from the same source—some beds particularly rich in conodonts that were subject to erosion during the deposition of the Crug limestone. These beds may well have been the basal parts of the Crug limestone itself, which became elevated and eroded in places. It appears that no more than this can be said at present, and not even this can be said with certainty.

One reason for the abundance of conodonts in the Crug limestone is probably the scarcity of terrigenous sediments. Provided that the number of conodonts was the same at different places during a given length of time, whereas the rate of sedimentation varied, there should be fewer conodonts per volume unit of sediment where sedimentation was rapid than where it was slow. This may explain why one generally must digest a large amount of rock from the very thick Ordovician sequence of Wales in order to recover the same number of conodonts as one can generally recover from a small sample from the relatively thin Ordovician strata of, for example, Sweden. With regard to conodont frequency, the Crug limestone compares rather well with an average Swedish sample.

COMPARISON WITH OTHER BRITISH ORDOVICIAN CONODONT FAUNAS

The following species have been found in the Crug limestone (figures in parentheses indicate the number of specimens of each species):

Acodus robustus (Rhodes) (22)
Acodus similaris Rhodes (17)
Ambalodus elegans Rhodes (3)
Ambalodus pulcher Rhodes (4)
Ambalodus triangularis Branson and Mehl (84)
Amorphognathus cf. *ordovicica* Branson and Mehl (38)
Amorphognathus n. sp. (6)
Cordylodus cf. *spurius* Branson and Mehl (100)
Cordylodus n. sp. (2)
Ctenognathus pseudofissilis Lindström, n. sp. (38)
Drepanodus sp. (24)
Hindeodella? sp. (1)
Icriodella superba Rhodes (15)
Ligonodina elongata Rhodes (2)
Oistodus cf. *inclinatus* Branson and Mehl (1)
Oistodus n. sp. (5)
Oistodus? sp. (1)
Ozarkodina rhodesi Lindström, n. sp. (70)
Ozarkodina pseudotypica Lindström, n. sp. (7)
Prioniodina pulcherrima Lindström, n. sp. (24)
Prioniodus variabilis Bergström (1)
Roundya divaricata (Rhodes) (1)
Roundya cf. *gracilis* (Rhodes) (10)
Roundya sp. (1)
Trapezognathus? sp. (1)
Trichonodella parabolica Lindström, n. sp. (27)
Zygognathus crugensis Lindström, n. sp. (17)
Gen. et sp. indet. (3)

There are no points of comparison with the Arenigian and basal Caradocian conodont faunas of Scotland (Lamont and Lindström, 1957). Those faunas, however, closely resemble contemporaneous faunas found in Sweden. It may perhaps be remarked that this resemblance between southern Scotland and much of Sweden extends beyond the characters of the conodont faunas. The sedimentation also shows parallelism in that deposition was slow, with little terrigenous silicate material, during the Arenigian and Llandeilian (thin chert shales in Scotland, relatively pure limestones over much of Sweden), whereas from the Caradocian onward, the rate of silicate deposition increased (graptolite shales and graywackes in Scotland, clayey limestones and shales in Sweden).

In the *Climacograptus wilsoni* zone of Scotland (Lindström, 1957), there are two species that may concern us here, viz., *Ambalodus* cf. *elegans* and *Prioniodina*? n. sp. *2*. The first of these species may possibly be identical with *Ambalodus elegans*, of the Crug limestone fauna. *Prioniodina*? n. sp. *2* can scarcely be distinguished from *Prioniodina pulcherrima*, but, then, this is a fairly generalized type. The Scottish fauna is older than the Crug limestone fauna, but possibly not very much so. In any case, the similarities between the two faunas are not very great.

When we compare the Crug limestone conodonts with those of the Gelli-grin and Pen-y-garnedd limestones, the differences must be stressed, rather than the obvious similarities that are to be expected between faunas that are relatively close to one another both in time and in space. The following species found by Rhodes (1953) in the two last-mentioned limestones have not been found in the Crug: *Amorphognathus complicatus*, *Cordylodus elongatus*, *C. geniculatus*, *Drepanodus altipes* Rhodes, 1953 (not Henningsmoen, 1948), *Drepanodus arcuatus* Rhodes, 1953 (not Pander, 1856), *Drepanodus similaris*, *D. striatus*, *Gyrognathus*? *superbus*, *Holodontus superbus*, *Icriodella de-*

forma Rhodes, 1539, *I. elongata* Rhodes, 1953, and *I. plana* Rhodes, 1953 (these three species are each founded on one specimen), *Ligonodina extensa*, *Lonchodus dentatus*, *L. distans*, *Oistodus abundans*, *O. breviconus*, *Paltodus acostatus*, *P. equicostatus*, *P. unicostatus*, *Phragmodus insculptus*, and *Stereoconus maximus*.

Of these, I attach most importance to the species identified by Rhodes as *Drepanodus altipes*, *D. similaris*, *Paltodus acostatus*, *P. unicostatus*, and *Phragmodus insculptus*, as they are of fairly characteristic habitus and are reported by Rhodes as common or abundant.

The following species found in the Crug limestone were not found in the Gelli-grin or the Pen-y-garnedd: *Acodus similaris*, *Amorphognathus* n. sp., *Cordylodus* n. sp., *Ctenognathus pseudofissilis*, *Hindeodella?* sp., *Oistodus* cf. *inclinatus*, *Oistodus* n. sp., *Oistodus?* sp., *Ozarkodina pseudotypica*, *Prioniodina pulcherrima*, *Prioniodus variabilis*, *Roundya* sp., *Trapezognathus?* sp., *Trichonodella parabolica*, *Zygognathus crugensis*, and Gen. et sp. indet. Of these, *Acodus similaris*, *Ctenognathus pseudofissilis*, *Prioniodina pulcherrima*, *Trichonodella parabolica*, and *Zygognathus crugensis* are numerically the most important.

The Crug fauna has three characteristic species in common with the fauna of the Keisley limestone (Rhodes, 1955), which is supposedly Ashgillian, although its exact age is not settled (Rhodes, 1955, p. 119). The contacts between the Keisley limestone and adjacent rocks are tectonic (Shotton, 1935). One must therefore rely largely on paleontologic data for an age determination.

Warburg (1925, p. 421) cites nine trilobite species as common to the Keisley limestone and a Swedish formation then called the "Upper *Leptaena* Limestone." A perusal of her text shows, however, that only four of these identifications *(Holotrachelus punctillosus*, *Lichas laciniatus*, *Pseudosphaerexochus conformis*, and *Sphaerexochus calvus)* are regarded as entirely sure. The "Upper *Leptaena* Limestone," now called the Boda limestone (Thorslund, 1936), is placed in the *Dalmanitina* series (op. cit.), which seems to correspond to the upper part of the British Ashgillian (cf. Spjeldnaes, 1957).

Although there are thus some macrofossils that suggest an Ashgillian age for the Keisley limestone, there are others that, if correctly determined (which is not necessarily the case), appear to indicate an earlier age. The trilobite *Platylichas laxatus*, reported by Reed (1897) from the Keisley limestone, occurs in the Actonian (upper Caradocian) of Shropshire (Dean, 1958) and in corresponding beds in Wales (Whittington, 1938). The brachiopods "*Orthis*" *actoniae*, "*O.*" *alternata*, and "*O.*" *vespertilio* are among those listed from the Keisley limestone by Reed (1897). *Harknessella vespertilio* occurs in the basal Caradocian of Shropshire, *Nicolella actoniae* and *Heterorthis alternata* at a somewhat higher level in the Caradocian (Dean, 1958). Williams (1953) found *Nicolella actoniae* in the Crug limestone.

At Swindale Beck – Knock Gill, 1½ miles northwest of the Keisley limestone outcrop, there seems to be a virtually unbroken sequence through the Caradocian to the Ashgillian (Shotton, 1935; Lamont, 1948). At the base, there are rhyolites and rhyolitic ashes, then follow the *Corona* beds, mudstones with brachiopods, trilobites and bryozoans, then the Dufton shales, mudstones, which may be correlated with the middle or upper Caradocian of Shropshire, and then the Ashgillian *Staurocephalus* limestone, with, among others, *Tretaspis seticornis*, which are overlain by Ashgillian shales. There seems, indeed, to be little room left in the Caradocian of this sequence for the Keisley limestone. According to Marr (1906) and Shotton (1935), there is an inlier of Dufton shale in the Keisley limestone outcrop. The inlier is interpreted as anticlinal by both of these authors. Marr found *Tretaspis seticornis* in the inlier. With the interpretation of the inlier as an anticline, it follows necessarily that the limestone surrounding it must be accepted as Ashgillian.

One of the characteristic conodonts found by Rhodes (1955) in the Keisley limestone is *Strachanognathus parva*. This species characteristically occurs in the lower Caradocian *Ludibundus* limestone of Sweden (Bergström, MS.).

To sum up, a part of the fauna and some of the stratigraphic evidence indicate an Ashgillian age for the Keisley limestone, but there also seems to be some paleontologic evidence for a Caradocian age. I have not seen the Keisley locality. With this very strong reservation, I may perhaps suggest a tentative solution of the apparent dilemma. Frequent comparisons have been made in the literature between the Boda limestone ("Upper *Leptaena* Limestone") of Dalecarlia, Sweden, and the Keisley limestone. Now, the Boda limestone is developed as local facies, as "reefs," surrounded by rocks of other lithologies, mainly shales, mudstones, and marly limestones (Thorslund, 1936). Shotton (1935, p. 687) has hinted at a "reef" character for the Keisley limestone. The lithologic description given by Reed (1897, p. 100) might, I think, almost as well have been a description of the reef limestones of Dalecarlia. These reefs were formed from early Caradocian to late Ashgillian time. For instance, at Skålberget (Thorslund, 1936, p. 32), both Caradocian and Ashgillian reef

limestones occur closely associated, with a strip of marly and shaly strata between them. Reasoning by analogy, is it possible that the Keisley limestone also is a locally developed reef-facies complex, comprising both Caradocian and Ashgillian strata, and with a stratigraphic inclusion of basal Ashgillian shales (the Dufton shale inlier)? If this be the case, it is probable that at least a part of the "Ashgillian" conodont fauna described by Rhodes (1955) is, in fact, Caradocian.

Three rather characteristic conodont species are shared by the Crug limestone and the Keisley limestone. They are *Acodus similaris*, *Ambalodus triangularis*, and *Amorphognathus* cf. *ordovicica*.

COMMENTS ON THE FAUNA

The material consists of about 750 specimens, 525 of which were in an identifiable condition. All are more or less fragmentary. Fragmentation took place largely before and during the final consolidation of the rock. Probably very little of it is due to the treatment of the material during and after digestion.

The specimens are mostly rather opaque and light brownish gray in colour, although a few are gray black, and some specimens, especially the smaller ones, are partly transparent and light-brown. The colour is a matter of preservations as all shades may appear in the same species. All of the species found, including those belonging to *Ambalodus* and *Amorphognathus*, are very clearly observed to possess lamellar structure.

As a rule, asymmetrical conodont elements occur as both right and left specimens. Accordingly, it is generally assumed that the conodont animal was bilaterally symmetrical, and that the different conodont elements of one side were mirror images of those of the other. This conception will meet difficulties in cases where one finds asymmetrical conodont elements that are all identical in plan, only "right" (or "left") specimens occurring. One such species, *Ozarkodina rhodesi* n. sp., is described in the present paper. So far, I feel that I must be content with pointing out the fact, without offering any interpretation.

COMMENTS ON THE SYSTEMATICS

In the following discussion, I have found reason to disagree in some respects with other conodont workers whom I greatly admire. I am well aware that my own opinions in these cases may be open to reasonable criticism. In such cases of disagreement, I have tried my best to justify my point of view, as this makes a discussion possible and as it would be discourteous not to do so.

Every conodont worker has again and ever again to face a nomenclatorial and taxionomic dilemma and to solve it according to his subjective inclination, his reason, and his conscience. One must decide on wether to continue to use a more or less admittedly artificial classification, or to try harder to establish natural taxa. So long as there is no satisfactory general solution to this dilemma (and I fear there will not be one for a long time), a really great danger lies in the tendency to make nomenclatorial and taxionomic decisions according to some routine developed at an early stage of the work.

It is conceivable, and indeed demonstrable, that an artificial classification can be so constructed that there should not be any hesitation concerning in what "form genus" a given "form species" should be placed. The objective classification is within relatively easy reach, if we are willing to use a rigorous artificial scheme; this approach would mean the end of some nomenclatorial confusion. Such a scheme may to a great extent bring together functionally similar (analogous) elements in the same taxon, but it may also bring together some phylogenetically related (homologous) elements and thus, occasionally, coincide with a "natural" classification. On the other hand, any artificial scheme would, if rigorously followed, in some cases put too much emphasis on the distinctions between obviously related species, and would separate them in different taxa.

If a "natural" classification were possible, it could in the long run be an aid to a true taxionomic concept of the actual organisms to which the elements belonged. However, clear cases of phylogenetic affinity between conodont elements are rather few. The bulk of the elements are of so simple a construction that it would be impossible to distinguish between homeomorphy and true affinity.

In this situation, I have favoured an artificial classification (Lindström, 1955*a*). For compound conodonts this classification uses the number, denticulation, and relative positions of the processes. As for the denticulation, the only criterion used is whether or not there is any denticulation. This may be too narrow a base, even for an artificial classification. Some arguments concerning the genus *Periodon* Hadding, 1913, are relevant here, insofar as they illustrate the point particularly well. The type species of the genus has anterior and posterior (oral) denticulate edges, and a lateral costa that is undenticulate. Accordingly, I have regarded these characteristics as diagnostic of the genus (Lindström, 1955*b*). Conodonts that are otherwise strikingly different may possess these characteristics. Now, Ethington, Furnish and Markewicz (1958) remark

that my characterization of the type of the genus is so broad that more than one genus is probably represented. If by this they mean to say that characteristics other than the ones stressed by me are worth taking into account when one defines a genus, and that, with my definition, species with differences that others may consider to be of generic importance will be brought together in *Periodon*, then one may agree with them. Professor W. C. Sweet has pointed out to me that a very large denticle some distance behind the cusp seems to him to be the most striking feature in the type species of *Periodon*, and that this feature is shared by a number of species placed in *Phragmodus* Branson and Mehl. According to him, *Periodon* is a senior synonym of *Phragmodus*, and the definition of the genus will be changed so as to emphasize the large denticle. Ethington, Furnish and Markewicz also regard *Periodon* as a senior synonym of *Phragmodus*. I am now in entire agreement with this view. Some species of *Periodon* may have a hint of a denticulated process that others have not. It must be emphasized, however, that it is generally not recommended to found a new genus solely on a single species that has some striking feature, such as a very large denticle, an oddly twisted process, or a uniquely restricted basal cavity.

There are several conodont genera (for example, *Bryantodus* Ulrich and Bassler, 1926; *Prioniodina* Ulrich and Bassler, 1926; *Ozarkodina* Branson and Mehl, 1933; *Bryantodina* Stauffer, 1935; and *Gyrognathus* Stauffer, 1935; see also Lindström, 1955*a*, p. 585, and Sannemann, 1955, p. 151) that have a cusp and only two processes, anterior and posterior, both denticulated. *Bryantodus*, *Ozarkodina*, and *Bryantodina* have higher, more fused denticles than *Prioniodina* and *Gyrognathus*. This makes the units bladelike. Furthermore, the first-mentioned genera are not as strongly arched as the two last-mentioned ones. *Ozarkodina* Branson and Mehl (1933, p. 51) was not compared with *Bryantodus* by its authors, but a comparison of species assigned to the two genera through the years shows that the difference is not very great. Bischoff and Ziegler (1957, p. 75) regard a thickened ridge along the processes as typical of *Bryantodus*, as compared with *Ozarkodina*. It seems to me that this is the only characteristic feature, as the widening of the basal cavity beneath the cusp which was said by Branson and Mehl (1933, p. 140) to characterize *Bryantodus* is less conspicuous in some species than in others, and is present to some extent in species of *Ozarkodina*.

Bryantodina Stauffer, 1935, resembles *Ozarkodina* and was compared with that genus by Sweet (1955). According to him, *Bryantodina* is straight and *Ozarkodina* is arched. Now, it is typical of *Ozarkodina*, as compared with, for example, *Prioniodina*, that its arching is relatively slight. It will also be apparent, upon examination of Stauffer's (1935*a*) figures of his *Bryantodina* species, that they are practically all moderately arched, even the type species. For this reason, it seems best to drop the genus *Bryantodina* as a junior synonym of *Ozarkodina*. All of the species of *Bryantodina* except one were named by Stauffer, so far as I can discover (cf. Fay, 1952). Of the two genera *Gyrognathus* and *Prioniodina*, the former genus is highly asymmetrical (cf. Rhodes, 1953), whereas *Prioniodina* approaches bilateral symmetry.

A further example of a similar nature is the conodont elements with a cusp and one (posterior) process, which is denticulated. To this group belong, among others, *Cordylodus* Pander, 1856; *Belodus* Pander, 1856; *Phragmodus* Branson and Mehl, 1933 (= *Periodon* Hadding, 1913); *Barbarodina* Stauffer, 1935; *Cyrtoniodus* Stauffer, 1935; *Plectodina* Stauffer, 1935; *Subcordylodus* Stauffer, 1935; and *Neoprioniodus* Rhodes and Müller, 1956. The statement made by Fay (1958), that *Cordylodus* lacks a bar (= process), may be based on a misconception of Pander's partly fragmentary material, as the complete specimens of Pander's species that are available to me have a very well developed posterior process (Lindström, 1955*a*).

Phragmodus (= Periodon) has a very characteristic habitus, with its large denticle some distance behind the cusp. *Belodus* lacks a distinct posterior process, the rather small denticles being crowded onto what appears to be the posterior part of the cusp itself. The other genera seem to be best regarded as junior synonyms of *Cordylodus* (see Lindström, 1955*a*).

Neoprioniodus, however, does require special discussion. Rhodes and Müller (1956) give the following diagnosis of the genus: "Compound conodonts consisting of a denticulated posterior bar, at the anterior end of which a large fang (main cusp) is developed. The base of this fang may or may not extend downward below the level of the bar to form an 'anticusp,' the anterior edge of which may or may not be denticulated. There is usually a basal cavity below the fang, which may be extended as a shallow groove on the aboral surface of the posterior bar."

The first sentence of this diagnosis exactly fits the genus *Cordylodus* (see Lindström, 1955*a*). The second sentence contains four statements. Taken together, the first two statements, that there may *or may not* be an anterior extension at the base of the cusp, are equally true of *Cordylodus*. The third statement in this sentence, that the anterior extension may be

denticulated, fits the genus *Prioniodina*, as already discussed above, which would make *Neoprioniodus* a junior synonym of that genus, as pointed out by Ziegler (1958*b*). The fourth statement (which is the alternative to the third) applies to *Cordylodus*. The third and last sentence of the diagnosis of *Neoprioniodus*, referring to the basal cavity, might equally well characterize *Cordylodus*.

Apart from the diagnosis, Rhodes and Müller refer to the characteristic "pick shape" of *Neoprioniodus*. The pick shape is a result of the anterior downward extension of the base. However, in the type species selected by them (*Prioniodus conjunctus* Gunnell), the anterior extension of the base is hardly more pronounced than in the type species of *Cordylodus*, *C. angulatus* Pander. Species in which the anterior basal part is drawn out into a long undenticulated process, but which are otherwise *Cordylodus*-like, belong to the genus *Paracordylodus* Lindström, 1955*a*. It appears, therefore, that *Neoprioniodus* is a junior synonym of *Cordylodus*, but that some species that might be assigned to it may belong to *Prioniodina* or *Paracordylodus*.

TERMINOLOGY, AND ORIENTATION OF SPECIMENS

For the terminology used here, see Lindström (1955*a*) and the present text-figure 2. The notations "anterior" and "posterior" are used for no other reason than that this is customary, and therefore will cause relatively little confusion. The more convex side of the main denticle, or cusp, is anterior, and the less convex, often concave, side is posterior. Thus, the posterior process is the one that departs from the concave edge of the cusp. This process frequently runs at about right angles to the cusp.

The exact orientation of the specimens may seem a trifling matter, but in fact it is not. This may appear from a scrutiny of a recent paper by Fay (1958). Fay has undertaken to give a key to the known conodont genera, an initiative for which he must be praised. In the key, precise orientation of the conodont elements plays an important part. Thus, *Neoprioniodus* and *Paracordylodus* are differentiated largely on the basis of orientation (the "backward curvature" mentioned by Fay depends upon how the elements are oriented); and, in a similar way, *Euprioniodina* is differentiated from *Neoprioniodus* and *Prioniodina*, and *Synprioniodina* from *Neoprioniodus* and *Subbryantodus*. To judge from the drawings accompanying Fay's paper, he has oriented many of the elements with the horizontal line running through the anterior and posterior extremities of the base. This orientation will be discussed somewhat further below. In the present connection it should merely be mentioned that it is not used consistently by Fay. Thus, *Euprioniodina* is oriented with what appears to be the posterior process horizontal, whereas *Neoprioniodus* and *Prioniodina* have the anterior and posterior extremities (nearly) horizontal; this gives rise to some of the alleged differences between the genera shown in Point 64 of Fay's key.

It may be mentioned in passing that Fay has used the degree of recurvature of the cusp in his key (Points 51 and 76). The recurvature may vary somewhat, even between conodont elements belonging to the same species. This feature is probably not very useful in differentiating genera.

The orientation of conodont elements with the horizontal line running through the anterior and posterior extremities of the base meets the difficulty that these extremities are most frequently broken, even in otherwise perfect specimens. This difficulty is well illustrated by Fay's orientation of *Cordylodus* and *Gothodus*, both of which are founded one somewhat fragmentary specimens. Furthermore, an orientation of this kind will be affected by intraspecific variations in the relative lengths of the processes.

Most conodont workers, including Fay, to some extent, very frequently orient compound conodonts with the oral edge of the posterior process horizontal. I have followed this usage in my previous papers, and will continue to do so. Furthermore, as before, I extend this usage to all conodonts. In the simple ones there is usually a straight basal part of the posterior edge. This part may be homologous with the posterior oral edge of compound conodonts. I refer to it as the oral edge, and orient it horizontal.

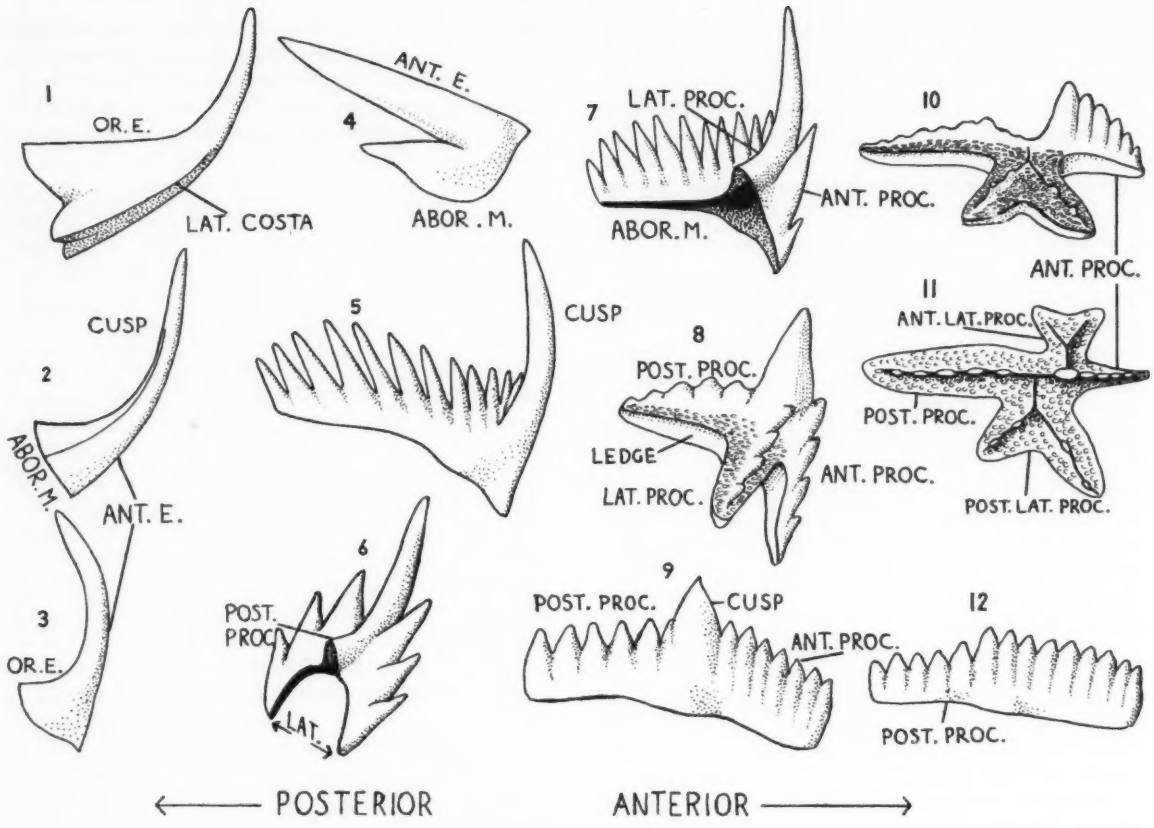
SYSTEMATIC DESCRIPTIONS

Genus **Acodus** Pander, 1856

It was suggested by Lindström (1955*a*, p. 544) that *Sagittodontus* Rhodes might be a junior synonym of *Acodus*. The general plan of *Sagittodontus*, as indicated by Rhodes (1953, p. 311), is that of *Acodus*, viz., a simple conodont with anterior and posterior edges and a costa, or lateral edge, on one side. Inspection of Rhodes' type specimen of *Sagittodontus robustus*, as well as of additional material of that species found in the Crug limestone, has confirmed this impression. *Sagittodontus robustus* Rhodes is linked with the more *Drepanodus*-like species of *Acodus* by such intermediate forms as *Acodus deltatus*, *A. gladiatus*, and *A. tetrahedron*, which were described from the Lower Ordovician of Sweden.

Acodus robustus (Rhodes)
Plate 4, figures 22–27

Sagittodontus robustus RHODES, 1953, Roy. Soc. London, Philos. Trans., ser. B, vol. 237, no. 647, p. 311, pl. 21, figs. 141–142.



TEXT-FIGURE 2

Orientation of the condont elements, and some terminology: 1–2, *Acodus*; 3, *Drepanodus*; 4, *Oistodus*; 5, *Cordylodus*; 6, *Trichonodella*; 7, *Zygognathus*; 8, *Ambalodus*; 9, *Ozarkodina*; 10–11, *Amorphognathus*; 12, *Ctenognathus*; 6, posterior-lateral view; 11, oral view; all others lateral views. Abor. = aboral; Ant. = anterior; E. = edge; Lat. = lateral; M. = margin; Or. = oral; Post. = posterior; Proc. = process.

Description: Rhodes has given a good description of the species, but as his orientation of it differs from mine, and as I have additional material, I consider it worth while to redescribe it.

The base is long and widely flaring, and the cusp is proclined. The anterior and posterior edges along the base are almost straight. They usually form an angle of about 35°, but the angle may occasionally be 45° and even somewhat more. On one side there is a costa, which as a rule is quite as well developed as the anterior and posterior edges. This costa runs at an angle of somewhat less than 30° to the anterior edge, whereas the angle that it makes with the posterior (oral) edge is about as great as the angle between that edge and the anterior edge. In this way, the base assumes the shape of a pyramid with a trigonal base, one of the pyramid facets being somewhat narrower than the others. Toward the aboral margin, which is the base of the pyramid, the facets curve inward a little in the middle, otherwise they are smoothly convex. The aboral margin is strongly arched between the edges, and also between the edges and the lateral costa, so that the edges and the costa project like three undenticulated processes. Very frequently, the basal fillings of the specimens project beyond the aboral margin.

The base is not offset from the cusp but continues with a very smooth curve into the latter. The cusp is slender and proclined. It is not compressed laterally. It is curved in the plane of the lateral face which does not possess a costa.

One might also look upon the species as having a posterior edge and two anterior ones, the lateral costa of the foregoing description becoming instead a further anterior edge. However, if the species is regarded in this manner, the cusp is then curved out of the anteroposterior plane. Furthermore, one specimen has been found in which there is a conspicuous flaring of the base on one

side, but no costa. In this specimen, the lateral character of the flare on which the costa should have developed is very clear. For these reasons, it may be considered justifiable to regard this species in the manner adopted by Rhodes and by the present author.

Occurrence: Crug limestone, in all samples except nos. 3 and 5; also Gelli-grin limestone (Rhodes, 1953).

Crug material: Twenty-two specimens.

Acodus similaris Rhodes
Plate 3, figures 6–9

Acodus similaris Rhodes, 1955, Geol. Soc. London, Quart. Jour., vol. 111, p. 124, pl. 10, figs. 7, 10, 14, 16, 18, 23, 26–28, 30.

Remarks: There is little to add to the description given by Rhodes. As he mentions, one side has a conspicuous costa. Along the other side of the posterior edge of the cusp there frequently runs another thin costa, but this costa does not reach the base. Consequently, the cross-section of the cusp is *Acontiodus*-like, whereas that is not the case with the base. Rhodes refers to some specimens with fine, longitudinal striae on the lateral faces. Actually, it appears that all specimens are provided with exceedingly fine longitudinal striations, which are visible at magnifications of about 200×. The same may possibly be true of other apparently smooth conodonts. See also Rhodes (1955, p. 125).

Occurrence: Crug limestone, samples 1, 3, and 4; Keisley limestone (Rhodes, 1955).

Crug material: Seventeen specimens.

Genus Ambalodus Branson and Mehl, 1933

Ambalodus elegans Rhodes
Plate 3, figures 20–22

Ambolodus elegans Rhodes, 1953, Roy. Soc. London, Philos. Trans., ser. B, vol. 237, no. 647, p. 278, pl. 20, figs. 21–25.

?Ambolodus robustus Rhodes, 1953, ibid., p. 279, pl. 20, figs. 26–27, 32–33.

?Ambolodus cf. *elegans* Rhodes. – Lindström, 1957, Geol. Fören. Stockholm, Förhandl., vol. 79, p. 172, pl. 1, fig. 21, text-fig. 2.

Remarks: According to Rhodes, the species *Ambalodus elegans* and *A. robustus* occur at the same localities. In habitus they are identical. The diagnostic difference, according to Rhodes, is that the lateral process is denticulate in *A. elegans* but does not carry denticles in *A. robustus*. Partial absence of denticles in some members of a group of otherwise very similar conodont specimens may, however, be a poor criterion for splitting the group into different species.

I have oriented the species somewhat differently from Rhodes, with the posterior process horizontal. I have little to add to his description, except with regard to the finer ornamentation. Along the processes there runs a ledge, which is continuous from one process to the other. The face of the lower (aboral) side of the ledge is smooth and shiny, and slopes a little inward toward the aboral margin. The upper, or oral, face of the ledge is finely and irregularly pitted. This feature shows that the species is one of the many intermediate forms occurring between platform conodonts and the ordinary prioniodid types of conodonts that began to appear in late Arenigian time and became abundant in the Middle and Upper Ordovician. The sides of the cusp are ornamented with very fine longitudinal striations.

Occurrence: Crug limestone, samples 1 and 2; Gelli-grin and Pen-y-garnedd limestones (Rhodes, 1953); (?)*Climacograptus wilsoni* zone, Scotland (Lindström, 1957).

Crug material: Three specimens.

Ambalodus pulcher Rhodes
Plate 3, figures 14–16

Ambolodus pulcher Rhodes, 1953, Roy. Soc. London, Philos. Trans., ser. B, vol. 237, no. 647, p. 279, pl. 20, figs. 38–41.

Remarks: Little can be added here to the description given by Rhodes. The ledges running along the sides of the processes are not very conspicuous, as compared with those of *Ambalodus elegans*. The cusp has a fine, but distinct, longitudinal striation.

Occurrence: Crug limestone, samples 1 and 2; Gelli-grin and Pen-y-garnedd limestones (Rhodes).

Crug material: Four specimens.

Ambalodus triangularis Branson and Mehl
Plate 2, figures 1–11

Ambalodus triangularis Branson and Mehl, 1933, Missouri, Univ., Studies, vol. 8, no. 2, p. 128, pl. 10, figs. 35–37. – Graves and Ellison, 1941, Missouri, Univ., School Mines and Met., Bull., Tech. Ser., vol. 14, no. 2, p. 5, pl. 3, figs. 29, 33–35. – Rhodes, 1953, Roy. Soc. London, Philos. Trans., ser. B, vol. 237, no. 647, p. 280, pl. 20, figs. 28–31. – Rhodes, 1955, Geol. Soc. London, Quart. Jour., vol. 111, p. 122, pl. 7, figs. 9–14.

Description: This species has already been described by Branson and Mehl, by Rhodes (twice), and by Glenister (1957, p. 722) (because of the rather vague nature of the figured specimen, I have found it best not to include the latter reference among the synonyms). All writers admit that it is highly variable. The description given below applies to my own material.

There are three denticulate processes. The anterior and posterior processes form an angle of about 90°. The lateral process originates at the anterior margin of the cusp, and curves slightly backward and diverges outward at an angle of 45° or less from the plane of the anterior and posterior processes. Whereas the other processes are subequal in size, robust, and rather wide, the lateral process is rather small. It is mostly broken. The posterior process as a rule is shorter and wider than the anterior. The denticles of the anterior process

are partly fused, mostly rather small compared with the cusp, and somewhat irregular in size and shape. They may be pointed. Those of the posterior process are even smaller. The cusp is very robust. As a rule, it is somewhat shorter than the processes. Its sides tend to be more and more rounded in the larger specimens, so that the cross section becomes oval. Otherwise the edges are sharp. The cusp, further, is suberect and leans a little toward the side, without a lateral process. The edges are straight or slightly convex, but either of them may occasionally be slightly concave. Along the sides of the processes there runs a ledge that is usually continuous from process to process, but which may be interrupted by a triangular depression between the posterior and lateral processes. There is usually, but not always, a well developed oral surface of the ledge, which is ornamented with densely spaced, very small, shallow pits. Specimens that do not show this clear tendency toward the platform type can still be distinguished as belonging to this species by the characters of the denticles and the cusp, and by the existence of a ledge, however small. The variation found in the species appears to be quite continuous. There are both right and left specimens.

Remarks: Bergström (MS.) has found two easily discernible subspecies of *Ambalodus triangularis* in the *Ludibundus* Limestone of Tväreu, Sweden. My material is, in part, rather close to his subspecies *erraticus*. Professor W. C. Sweet has kindly sent me a few American specimens, from the Eden group of southwestern Ohio. They fall within the range of variation of my material.

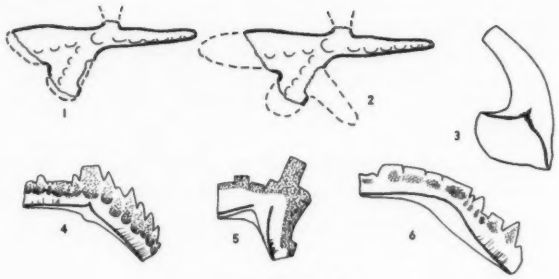
Occurrence: Crug limestone, in all samples; Maquoketa-Thebes, Missouri (Branson and Mehl); Maravillas chert, Texas (Graves and Ellison); (probably) Maquoketa shale, Iowa (Glenister); Economy shale, Eden group, Ohio; Gelli-grin and Pen-y-garnedd limestones (Rhodes, 1953); Keisley limestone (Rhodes, 1955).

Crug material: Eighty-four specimens.

Genus **Amorphognathus** Branson and Mehl, 1933

According to Branson and Mehl (1933, p. 126), this genus is irregularly branched. Sweet (1955, p. 248) also regards the branching as typically irregular, and adds that the genus is fibrous. Glenister (1957, p. 722), in her description, refers to the irregularity of the genus. Rhodes (1953, p. 282) does not modify Branson and Mehl's description, but gives a figure (text-fig. 2) with appended nomenclature in which an assumption of a certain regularity seems to be implicit.

Upon analyzing the type species, *Amorphognathus ordovicica* Branson and Mehl, 1933, in the manner used by Rhodes (1953, text-fig. 2), one finds an anteroposterior axis with two lateral processes, one departing somewhat more anteriorly than the other, which is on the opposite side. There are also other species with a similar plan. Bergström (MS.) describes well preserved material of



TEXT-FIGURE 3

1–2, two possible interpretations of the type of *Balognathus* Rhodes (1953, pl. 20, fig. 50); thick lines = undamaged margins of type specimen; thin, wavy lines = fractures; broken lines = reconstructed outlines: 1, *Balognathus* is an *Amorphognathus* with the posterior lateral process consisting of a single lobe; 2, the type specimen of *Balognathus* closely resembles *Amorphognathus* cf. *ordovicica* Branson and Mehl; 3–6, diagrams of specimens in transmitted light; thick line = outline of basal cavity; thin, closely set lines = indications of growth lamellae; stipples = portions clouded by small granules. 3, *Drepanodus* sp., no. LO 3977 t, from sample 1; 4, *Ozarkodina pseudotypica* Lindström, n. sp., no. LO 4001 T, from sample 1; 5, *Zygognathus crugensis* Lindström, n. sp., no. LO 3957 t, from sample 1; 6, *Ozarkodina rhodesi* Lindström, n. sp., no. LO 4010 t, from sample 1.

such species from the lower Caradocian of Sweden. In accordance with Bergström, I propose that the generic name *Amorphognathus* be restricted to species with a more or less straight central axis consisting of an anterior and a posterior process, and with lateral processes that may be bilobate, the lateral process of one side being situated somewhat more anteriorly than those of the other. My material of *Amorphognathus* is fragmentary but otherwise well preserved. It shows distinctly that the genus is lamellar and not fibrous. (See the aboral view of the interior of a basal cavity, pl. 2, fig. 14).

It appears to me that *Balognathus* Rhodes, 1953, is most probably a junior synonym of *Amorphognathus*, and that, indeed, the type species of the former genus may be a synonym of that of the latter. Text-fig. 3(1–2) illustrates this point. The type specimen of *Balognathus* is broken exactly at the point where the lobes of *Amorphognathus ordovicica* should have departed. If the specimen is reconstructed with these lobes, good *Amorphognathus* cf. *ordovicica* Branson and Mehl is obtained. Although it is admitted that Rhodes' interpretation may be correct, it should therefore also be borne in mind that, if it is not correct, *Balognathus* and *Amorphognathus* may possibly have the same type species. In any case, *Balognathus* will be included within Bergström's redefinition of *Amorphognathus*.

Amorphognathus cf. **ordovicica** Branson and Mehl
Plate 2, figures 12–17

?*Amorphognathus ordovicica* BRANSON AND MEHL, 1933, Missouri, Univ., Studies, vol. 8, no. 2, p. 127, pl. 10, fig. 38.

Amorphognathus ordovicicus Branson and Mehl. – Rhodes, 1953, Roy. Soc. London, Philos. Trans., ser. B, vol. 237, no. 647, p. 283, pl. 20, figs. 47–49. – Rhodes, 1955, Geol. Soc. London, Quart. Jour., vol. 111, p. 123, pl. 9, fig. 4.

?Balognathus expansus Rhodes, 1953, Roy. Soc. London, Philos. Trans., ser. B, vol. 237, no. 647, p. 285, pl. 20, figs. 50–53, 57.

Remarks: As there are other species of *Amorphognathus* that are similar to Branson and Mehl's figure of the type species, *A. ordovicica*, I have hesitated to identify my material with that species. The identity with the species described by Rhodes (1953) is obvious, however. If this species were shown beyond doubt to be identical with *A. ordovicica* Branson and Mehl, then one of the question marks in the synonymy could be dropped.

A little can be added to the description given by Rhodes (1953). I refer to the "bars" of Rhodes as "processes." I refer to the posterior and anterior outer bars of Rhodes collectively as a (bilobate) anterior lateral process, because they arise as a single process on the side of the cusp. The inner bars of Rhodes also arise as a single lateral process, which is then split into two lobes. As this process departs farther back than the one already referred to, I consequently call it a (bilobate) posterior lateral process.

Description: The anterior process is blade-shaped, with a row of rather high, narrow, fused, and erect denticles that grow steadily higher backward to culminate in the cusp, after which there are no denticles of this type. The cusp is erect, rather blunt, provided with rounded sides. It is not very much larger than the denticle next in front of it. The ledge that runs subparallel to the aboral margin is not very wide along the anterior process, but as high as along the other processes. The anterior process is straight or slightly arched.

The anterior lateral process is attached on one side, opposite the cusp. As it has not been found *in situ*, it cannot be described. At its origin there is a shallow longitudinal concavity on the flank of the cusp, and in the middle of this concavity there is a very thin costa that runs from near the apex of the cusp, out on the oral surface of the part of the anterior lateral process that is preserved.

The posterior process may be the longest of the four. It forms a very slightly arched continuation of the anterior process, so that in lateral view the whole unit is somewhat arched. The process forms a slight sigmoid curvature that is further accentuated by the low submedian crest that runs along it. Along the crest there are distributed a number of low, irregular denticles, the largest of which is situated about at the midlength of the process.

The posterior lateral process is an outgrowth from the posterior process, and is situated behind the cusp and in front of the largest denticle of the posterior process. As it does not dip away in an aboral direction, it lies roughly in the plane of the other processes. At its origin there is a thin crest that branches out from the crest of the posterior process at an angle of 90°. This initial crest almost immediately splits into two, which diverge at about 60° and which form the median crests of the two lobes of the posterior lateral process. The anterior of these lobes is much the longer, being almost as long as the whole of the posterior process. The crests of the posterior lateral process may carry a few denticles.

The oral surface of the ledge of the posterior process and the posterior lateral process is rather wide, somewhat convex, and is ornamented with small, shallow, and closely spaced pits that would not appear in an illustration with a reasonable magnification. The aboral strip of the ledge is smooth and shiny, and not very wide. The basal cavity is deep.

In the larger specimens, various irregularities may occur. Thus, the outline of the ledge in oral view becomes less even, with bulges or notches here and there. There may develop denticles beside the crest, well out on the ledge. Three examples have been found in which the median crest splits into two denticulate crests at the distal end of a process, so that this end as a consequence becomes truncated rather than pointed. In all such cases, investigation of the growth lamellae as seen in aboral view proves that the unit, when it was smaller, had a more regular outline.

Occurrence: Crug limestone, in all samples; (?)Maquoketa-Thebes, Missouri (Branson and Mehl); Gelligrin and Pen-y-garnedd limestones (Rhodes, 1953); Keisley limestone (Rhodes, 1955).

Crug material: At least thirty-eight identifiable fragments and one nearly complete specimen.

Amorphognathus n. sp.
Plate 2, figures 18–19

Description: The anterior process is narrower than the other processes when seen in oral view. There is a row of rather small, more or less discrete denticles of subequal but slightly irregular sizes. There is no cusp. The ledges that run along the sides of the anterior process are narrow. The process is somewhat arched. It is not quite distinct from the posterior process, but there is a slight upward concavity of the unit where the two processes can be said to meet. Otherwise the anterior and posterior processes are roughly on a line. The anterior lateral process departs on one side, on the hindmost portion of the anterior process, and the posterior lateral process departs on the other side, from the foremost portion of the posterior process. The posterior lateral process is bilobate at its extremity, with the anterior lobe the larger. The tip of the anterior lobe is of more or less irregular, truncated shape. The lobes carry somewhat irregular, curved, denticulate median crests. The anterior lobe may have feeble accessory marginal crests at the tip. The process does not dip away in an aboral direction.

The posterior process is the longer. It is somewhat arched. In oral view, it is slightly curved. Its median crest carries a number of subconical, pointed, but

rather low denticles. The ledge of the lateral and posterior processes is rather wide. The oral surface is ornamented with densely spaced shallow pits, which are so small, however, that the surface nevertheless has a lustre. The basal cavity is deep and wide, and extends all along the unit.

Occurrence: Crug limestone, samples 1–3.

Material: Six specimens.

Genus Cordylodus Pander, 1856

Cordylodus cf. **spurius** Branson and Mehl
Plate 4, figures 19–21

?Cordylodus(?) spurius Branson and Mehl, 1933, Missouri, Univ., Studies, vol. 8, no. 2, p. 117, pl. 10, fig. 4. – Rhodes, 1953, Roy. Soc. London, Philos. Trans., ser. B, vol. 237, no. 647, p. 301, pl. 21, fig. 133.

Description: The posterior process is long and slowly tapering. It carries at least eight or nine more or less discrete, reclined denticles, the posterior ones of which are higher than the basal sheath. The denticles are pointed. Their edges are straight or slightly concave. They are compressed laterally. The cusp is large, slowly tapering, and suberect or slightly proclined. Its cross section is drop-shaped, as it is rounded posteriorly and thins into an edge anteriorly. The posterior edge is represented by a thin costa. The basal portion of the anterior edge of the unit is straight or very slightly concave, and slants slightly backward aborally. The anterobasal angle is rather sharp. Thus, the anterior part of the base forms a short prong-like structure.

The anterior part of the aboral margin may be developed in two different ways, which are illustrated by the specimens figured on plate 4. It may have uninterrupted, rather smooth convexity, as in figure 21, or it may have marked convexity opposite the anterior end of the posterior process, as in figures 19 and 20. There are intergradations between these tendencies. The species is not symmetrical, as the basal cavity flares rather strongly toward one side. On the same side the denticles are set off from the basal-sheath portion of the process, whereas on the other side they stand level with the face of the process. There are both right and left specimens. The basal cavity is rather deep. Its tip is opposite the posterior margin of the cusp.

Occurrence: Crug limestone, samples 1–3 and 1956; (?)Maquoketa-Thebes, Missouri (Branson and Mehl); (?)Gelli-grin limestone (Rhodes).

Crug material: One hundred specimens.

Cordylodus n. sp.
Plate 3, figures 34–36

Description: Only two specimens are available. Part of the posterior process seems to be missing in both. The posterior process is denticulate. The denticles are small, blunt, and partly fused. The cusp seems to be long and tapering, but slowly. It is suberect. In cross section it is subcircular. There are no posterior and anterior edges. Instead, there are two shallow longitudinal furrows anteriorly, one on each side of the cusp, and a further furrow posteriorly. The anterior furrows are not situated equally as far anteriorly on the two sides. The basal part of the anterior margin slants backward aborally. The anterobasal angle is about 90°. The abotal margin shows a sigmoidal curvature, as it first (anteriorly) runs almost normal to the anterior margin, then curves abruptly in an oral direction, and then (posteriorly), opposite the foremost denticles, again curves so as to run parallel to the oral margin of the process. One of the most conspicuous features is a zone of inverted basal cavity that runs along the whole of the aboral margin. The basal cavity seems to be shallow.

Occurrence: Crug limestone, sample 1 (two specimens).

Genus **Ctenognathus** Pander, 1856

Some discussion has arisen concerning this genus. The type species (the first species described) of Pander's genus *Ctenognathus* is *Ctenognathus murchisoni* Pander (1856, p. 32). The species was found at Rootsiküle and Sandel (Pander, 1856, p. 32), where there are light yellow limestones (Pander, 1856, p. 64), which indisputably belong to the highest beds of Ösel Island (Pander, 1856, p. 65). The type specimen (Gross, 1954, p. 75) is the one figured by Pander on plate 4, figure 17a.

Gross (1954) has described material containing a conodont element that he assigned to *Ctenognathus murchisoni*. The material came from stage K_1 (Rootsiküla formation) at Wessiko on the island of Ösel. The material seems to be so similar to Pander's figure 17a, plate 4, that the identification appears highly plausible. Furthermore, it appears that Gross' material may have come from the same stratigraphic level as Pander's *Ctenognathus*, as will appear from the following discussion.

Pander's fish bed is evidently situated south of Rootsiküla (Twenhofel, 1916, p. 331). Its stratigraphic position is well up in stage K_1. It contains, among others, *Platyschisma helicites* and the *Ctenognathus* species with which we are concerned here. Gross' material came from Vesiku (Wessiko), where, according to Luha (1930, p. 13), fish remains and *Platyschisma helicites* are found in beds belonging to stage K_1.

Now, *Ctenognathus murchisoni*, as described by Gross, doubtless belongs to the genus *Spathognathodus* Branson and Mehl, 1941. If Gross' opinion that his material is conspecific with *Ctenognathus murchisoni* Pander, 1856 (pl. 4, fig. 17a) is accepted, then his rejection of the genus *Spathognathodus* as a junior synonym of *Ctenognathus* must also be accepted. It may be that some of the species referred to *Ctenognathus* by Pander do not

actually belong there (see Ziegler, 1958*a*). This does not mean that the position of the genus is doubtful. If the characteristics of the type species are established, as they seem to have been in this case, then the genus can be defined, and there need be no doubt concerning its position. I believe, therefore, that it is preferable to agree with Gross (1954) and with Müller (1956) in regarding *Spathognathodus* as a junior synonym of *Ctenognathus*.

Ctenognathus pseudofissilis Lindström, **new species**
Plate 4, figures 1–9

Derivation of name: From *Ctenognathus fissilis* (Branson and Mehl).

Holotype: Geol. Inst. Lund, specimen LO 3994 T (pl. 4, figs. 1–3).

Diagnosis: A *Ctenognathus* that is at least three times as long as high, with the basal cavity extending along the processes, with the denticles of the posterior process conspicuously lower than those of the anterior, and with the posterior (shorter) process flexed laterally so as to form an angle of about 145° with the anterior process.

Description: In lateral view the species is almost straight or only slightly arched. The posterior process is curved laterally, so that in oral view it forms an angle of about 145° with the anterior process. It is approximately half as long as the anterior process. The unit is high and thin, blade-like. The denticles are erect. They are free only at the apices, which may be rather pointed. The basal, fused parts of the denticles make up slightly less than half the height of the processes. The whole unit may have as many as twenty-five denticles. The denticles of the anterior process are larger than those of the posterior. The denticle that is situated above the deepest portion of the basal cavity, and which can be regarded as the cusp, may be somewhat larger than the others. The denticles just behind it are usually small. In cross section, the denticles are lanceolate. The basal cavity is rather wide and deep in the posterior part of the anterior process. Its forward extension along the anterior process is narrow and not very deep, disappearing entirely at the anterior end. Along the posterior process, the basal cavity is also rather shallow, but wider than along the anterior process. In addition to the lateral curvature of the posterior process, there may also be a slight twisting of this process. There are both right and left specimens.

Remarks: This species is superficially similar to *Ctenognathus fissilis* (Branson and Mehl) (1933, p. 185), from the Devonian Grassy Creek shale of Missouri, but differs from that species in that the basal cavity does not extend into the denticles, and in that the posterior denticles are markedly smaller than the anterior ones.

Occurrence: Crug limestone, in all samples except no. 4.

Material: Thirty-eight specimens.

Genus DREPANODUS Pander, 1856

Drepanodus sp.
Plate 3, figures 1–5; text-figure 3:3

Remarks: The species of *Drepanodus* are notoriously difficult to differentiate unless a large amount of material is available for each species. It is often useless to make identifications based on general similarities between specimens of different ages or geographic occurrence, as similarities may be of little taxionomic significance in such simple forms.

Description: The cusp is long, recurved from the base, and slowly tapering. Its cross section is lanceolate. The edges are sharp, and the sides are smoothly convex except that there may be some feeble concavity near the edges. The basal cavity is wide and deep, with its tip at the middle of the basal portion of the cusp. Its margins in side view are nearly straight. It may be slightly irregular, opening a little to one side. It flares rather widely, especially posteriorly. The oral edge is not quite straight and not very long. The aboral margin is convex, especially posteriorly. It meets the oral edge at an angle of about 90° or less. It may be only slightly deflected laterally. The surfaces of the specimens are glossy, but under a magnification of 200 ×, they are seen to bear fine, densely spaced longitudinal striations.

One unusually regular specimen (pl. 3, figs. 3–4) is also assigned to this species, although it is uncertain whether or not it belongs there. Apart from its great regularity, it differs from other specimens in the fact that the anterior edge is not straight but is slightly concave near the anterobasal angle.

Occurrence: Crug limestone, samples 1–3, 5, and 1956.

Material: Twenty-four specimens.

Genus HINDEODELLA Ulrich and Bassler, 1926

Hindeodella? sp.
Plate 1, figure 10

Description: Only one specimen was found. Both ends are broken, and none of the larger denticles is complete. The basal part of the process is rather thin, and no higher than the largest denticle is wide. The anterior part of it makes an angle of 135° with the posterior part, and is somewhat deflected laterally. The posterior portion is straight. On the preserved part of the anterior portion there are two denticles, the foremost of which is rather large and erect. The small denticle that comes next is broken at the base. Then comes the largest denticle, which is situated at the bend of the process. It seems to have been somewhat reclines or recurved. Its cross section is subelliptical, with the widest dimension anteroposteriorly. There are very thin costae anteriorly and posteriorly. The denticles on the posterior portion are reclined. Just behind the largest denticle there is a nondenticulate space, then there is a very small denticle, then a broken denticle, which is larger, after which there follows a denticle that is almost as wide anteroposteriorly as the largest denticle. Then there is another

small denticle. The fragmentary process is terminated posteriorly by a further large denticle. The basal cavity is narrow and seemingly very shallow. It does not flare beneath the largest denticle.

Occurrence: Crug limestone, sample 1956 (one specimen).

Genus Icriodella Rhodes, 1953

Icriodella superba Rhodes
Plate 4, figures 10–16

Icriodella superba Rhodes, 1953, Roy. Soc. London, Philos. Trans., ser. B, vol. 237, no. 647, p. 288, pl. 20, figs. 54, 58, 62–63, 65, 78.

Icriodella superba Rhodes var. *acuta* Rhodes, 1953, ibid., p. 288, pl. 20, figs. 59–60, 64, 66, 71–73, 77.

Description: As a rule, the processes are broken apart, and only the posterior process can be identified. Only one comparatively complete specimen (pl. 4, figs. 14–16) was found. The denticles of the posterior process are arranged two and two, facing each other, on each side of the oral crest. They are erect and discrete, except that denticles belonging to the same couple may be more or less fused with one another across the oral crest. The apices are rather blunt. Further, the denticles are rather irregular, faceted, and angular, and are provided with thin ridges. It is especially common that there is a thin ridge uniting the denticles belonging to the same couple. Rather frequently, the anterior face of the denticle is the steeper. The denticles at about the midlength of the process are by far the largest. Those at the anterior and posterior ends are fairly small, and may stand singly, on the oral edge of the process.

The cusp is prominent, blunt and irregular. Rather posteriorly, on one side, it carries a costa, which is continued on the basal sheath as an angular flare that may perhaps be regarded as an undenticulated process. Little is left of the anterior process. The basal cavity is deep, particularly in the posterior process. As a rule, the basal sheath is thin. On the interior surface of the cavity, it can be seen that growth was lamellar.

Occurrence: Crug limestone, in all samples except no. 5; Gelli-grin and Pen-y-garnedd limestones (Rhodes).

Crug material: Fifteen specimens.

Genus Ligonodina Ulrich and Bassler, 1926

Ligonodina elongata Rhodes
Plate 3, figures 26–27

Ligonodina elongata Rhodes, 1953, Roy. Soc. London, Philos. Trans., ser. B, vol. 237, no. 647, p. 305, pl. 21, figs. 130–131. – Bergström, MS., Geol. Fören. Stockholm, Förhandl., vol. 81 (in press, 1949).

Occurrence: Crug limestone, in samples 1 and 1956; Gelli-grin and Pen-y-garnedd limestones (Rhodes); *Ludibundus* Limestone, Tvären, Sweden (Bergström).

Crug material: Two specimens.

Genus Oistodus Pander, 1856

Oistodus cf. **inclinatus** Branson and Mehl
Plate 3, figure 10

?Oistodus inclinatus Branson and Mehl, 1933, Missouri, Univ., Studies, vol. 8, no. 2, p. 110, pl. 9, fig. 8. – Stauffer, 1935, Jour. Pal., vol. 9, no. 7, p. 610, pl. 75, figs. 9, 14. – Graves and Ellison, 1941, Missouri, Univ., School Mines and Met., Bull., Tech. Ser., vol. 14, no. 2, pl. 2, fig. 16. – Glenister, 1957, Jour. Pal., vol. 31, no. 4, p. 726, pl. 86, fig. 11.

?Oistodus abundans Branson and Mehl. – Stauffer, 1935, Jour. Pal., vol. 9, no. 7, p. 609, pl. 75, figs. 12–13, 19.

?Oistodus n. sp., Mehl and Strothman, 1940, in Branson, 1944, Missouri, Univ., Studies, vol. 19, no. 3, pl. 13, figs. 1–2.

Description: Only one fragmentary specimen was found. The apex of the cusp is broken and so is the posterior portion of the base. The specimen is an *Oistodus* with a straight, strongly reclined cusp and a relatively small base. The anterior edge is very slightly concave apically. The aboral margin and the anterior edge approach one another at about right angles, but the anterobasal angle is rounded off. The aboral margin shows a smooth, subcircular curvature. The posterior edge of the cusp is smoothly convex, with only a hint of a groove along the posterior edge. The other side has a rounded carina running along its center and shallow grooves running along the anterior and posterior edges. The basal cavity opens more toward the side bearing the carina. It is rather shallow anteriorly, where it reaches the anterobasal angle. Otherwise, it is rather deep and wide.

Occurrence: Crug limestone, sample 1 (one specimen); ?Plattin limestone, Missouri (Branson and Mehl); ?Decorah shale, Minnesota (Stauffer); ?Fort Pena formation, Texas (Graves and Ellison); ?Maquoketa formation, Iowa (Glenister); ?Kimmswick limestone, Missouri (Mehl and Strothman).

Oistodus n. sp.
Plate 3, figure 13

Description: The cusp is reclined. Its edges are almost straight, subparallel. Its cross section is lanceolate. Its width is greater than the height of the base. The anterior edge curves somewhat toward the anterobasal angle. The angle between the anterior part of the aboral margin and the straight portion of the anterior edge is acute, but due to the curvature of the anterior edge, the anterobasal angle is actually more than 90°. Along the aboral margin, a slight concavity is first observed, then, beneath the angle between the cusp and the oral edge, there is a strong convex curve, so that the posterior part of the aboral margin runs parallel with the cusp. The basal cavity is rather shallow and triangular in lateral view, with concave outlines, and with the apex near the angle between the cusp and the oral edge of the base. All along the preserved portion of the base there runs

aborally a thin zone of receding growth lamellae, an "inverted basal cavity" (Lindström, 1955*a*, p. 537).

Occurrence: Crug limestone, sample 1.

Material: Five specimens, all fragmentary.

Oistodus? sp.
Plate 3, figures 11–12

Description: Only one specimen was found. As the extremities of this specimen are broken, a sure identification cannot be made. The cusp is reclined at about 45°. It is lanceolate in cross section, with edges that are rendered rather thin and sharp by shallow depressions running alongside them. The base is drawn out anteriorly, and is broken. It is also broken posteriorly. The basal cavity seems to be fairly deep, with its apex at the posterior part of the base of the cusp. On one side, it flares a little just beneath the angle between the cusp and the oral edge of the base. There is a depression on the basal sheath along the aboral margin anterior to this bulge. There seems to be a scarcely discernible denticle just where the anterior end of the specimen is broken, so that the specimen may be a *Falodus* instead of an *Oistodus*. The cusp is provided with very fine longitudinal striations.

Occurrence: Crug limestone, sample 3 (one specimen).

Genus OZARKODINA Branson and Mehl, 1933

Ozarkodina rhodesi Lindström, **new species**
Plate 1, figures 1–9; text-figure 3:6

?Bryantodina? sp., RHODES, 1953, Roy. Soc. London, Philos. Trans., ser. B, vol. 237, no. 647, p. 316, pl. 20, fig. 34.

Derivation of name: In honor of Professor Frank H. T. Rhodes.

Holotype: Geol. Inst. Lund, specimen LO 3951 T (pl. 1, figs. 1–2).

Diagnosis: An *Ozarkodina* with anterior and posterior processes subequal in length, with a very shallow basal cavity, which is narrow except beneath the cusp, with the anterior process somewhat higher than the posterior process, with no or very small denticles just in front of the cusp, and with large denticles farther anteriorly.

Description: The processes are somewhat compressed laterally, are about equally long, and form an angle of about 145°. The posterior process is straight or slightly arcuate. The anterior process is almost straight, but is somewhat convex aborally. The cusp and denticles are rather short, stout, and straight. They are erect or somewhat proclined. They are subconical and somewhat flattened laterally, and are perched on a rather high base with smooth sides. They tend to be fused basally, especially in the larger specimens. As a rule, the cusp is markedly larger than any of the denticles. The denticles of the posterior process are all of about the same size. The hindmost denticles on the anterior process are very small and tend to disappear entirely during growth, so that a nondenticulate space develops between the cusp and the anterior denticles. The latter are fairly large except at the extreme anterior end. As a rule, one of the anterior denticles is larger than the others.

The basal cavity is relatively shallow and does not protrude with a tip into the base of the cusp (see text-fig. 3: 6). It is somewhat widened to one side at the cusp. On the other side, the basal sheath may be slightly flexed in a more random manner. In a number of specimens, the basal sheath is very slightly curved outward along the whole or much of the aboral margin, so that a very narrow frill is offset. A good example of this was observed along the posterior process of the specimen shown in plate 1, figure 2. Sometimes the basal sheath is not as high on one side as on the other, in which case the basal cavity opens slightly laterally. It is apparent from what has been said that this species is not quite symmetrical, as the basal cavity flares more to one side than to the other. Moreover, the cusp and the denticles are more strongly convex on the side on which the cavity is widened. The posterior process may be slightly twisted, so that the denticles come to lean toward that same side. Such is the case in the type specimen (pl. 1, figs. 1–2). It is most remarkable that the widening of the basal cavity is always found on the "right" side. Sixty-one of the available specimens from samples 1–4 were sufficiently complete for a determination of this condition.

The anterior end is more often preserved than the posterior. It is rounded and often somewhat translucent, so that one can see the growth lamellae, which follow the curvature of the anterior margin. How the anterior ends of the growth lamellae appear in transmitted light is also shown in some of the specimens figured on plate 1 (figs. 7–9). A further growth phenomenon can be inferred from text-figure 3:6. At the base of each denticle there is a space, which is rendered opaque by a multitude of very small dispersed granules. It can be seen that each of the major denticles has such a clouded portion basally. However, just in front of the cusp there are three small spaces with granules, although only two denticles appear on the exterior of the conodont. Clearly, one denticle that was originally present has since been covered by the later growth lamellae of the two adjacent denticles. Later still, the growing cusp would have invaded the space of the two denticles that are now left, and would have partially obliterated them.

Occurrence: Crug limestone, samples 1–5; ?Gelli-grin limestone (Rhodes).

Crug material: Seventy specimens.

Ozarkodina pseudotypica Lindström, **new species**
Plate 4, figures 17–18; text-figure 3:4

Derivation of name: From the resemblance to *Ozarkodina typica* Branson and Mehl.

Holotype: Geol. Inst. Lund, specimen LO 4001 T (pl. 4, fig. 18).

Diagnosis: A laterally compressed *Ozarkodina* with narrow and shallow basal cavity and with numerous subequal-sized, fused, pointed denticles on each process, those of the anterior process markedly higher than those of the posterior.

Description: The processes lie in one plane and make an angle of about 135° with one another. As the aboral margin is smoothly curved, the whole unit appears rather evenly arched. The processes are high, thin, and smooth-faced, with equal sides, so that the unit is blade-like and bisymmetrical. The posterior process is fragmentary in all the specimens. It is somewhat less high than the anterior process, the denticles being smaller. The denticles of the anterior process may number as many as ten. They diverge a little, so that those at the anterior end are rather strongly proclined, and those nearest to the cusp are suberect. Laterally they are thin, with lanceolate cross sections. Their heights are two to three times their anteroposterior widths. They vary but little in size along the process except that the denticle at the anterior end is quite small. They are fused throughout most of their height. The apices are sharp and pointed.

The cusp is erect and resembles the denticles of the anterior process except that it is twice as wide and nearly twice as high. In larger specimens, it may have one or two denticles incorporated before and behind it. The denticles of the posterior process are smaller and somewhat more unequal-sized than those of the anterior process. Like the latter denticles, they are partly fused. They are erect. The basal cavity is very narrow and shallow. It sends a pointed extension into the base of the cusp, and it also flares a little on both sides beneath the cusp. In transmitted light it becomes apparent that growth was lamellar.

Remarks: The species somewhat resembles *Ozarkodina concinna* Stauffer of Mehl and Strothman (in Branson, 1944, pl. 13, figs. 29–33, 42), but it differs from that species, among other things, in having a narrower basal cavity. It differs from *Ozarkodina typica* Branson and Mehl in having relatively low posterior denticles.

Occurrence: Crug limestone, samples 1 and 2.

Material: Seven specimens.

Genus PRIONIODINA Ulrich and Bassler, 1926

Prioniodina pulcherrima Lindström, **new species**
Plate 3, figures 28–30

Ozarkodina n. sp., MEHL AND STROTHMANN, 1940, in BRANSON, 1944, Missouri, Univ., Studies, vol. 19, no. 3, pl. 12, figs. 16–17.

Prioniodina? n. sp. *2*, LINDSTRÖM, 1957, Geol. Fören. Stockholm, Förhandl., vol. 79, no. 2, p. 175, pl. 1, fig. 22; text-fig. 2.

PLATE 1

All magnifications × 65. The specimens are deposited at the Geological Institute of Lund University. All specimens are from the Ordovician (Caradocian) Crug limestone of Crug Farm, near Llandeilo, Wales.

1–2 *Ozarkodina rhodesi* Lindström, n. sp.
Holotype, no. LO 3951 T, two lateral views; sample 2.

3–9 *Ozarkodina rhodesi* Lindström, n. sp.
3–4, no. LO 3952 t, two lateral views; 5, the same, oral view; 6–7, no. LO 3953 t, two lateral views; 8–9, no. LO 3954 t, two lateral views. All from sample 1.

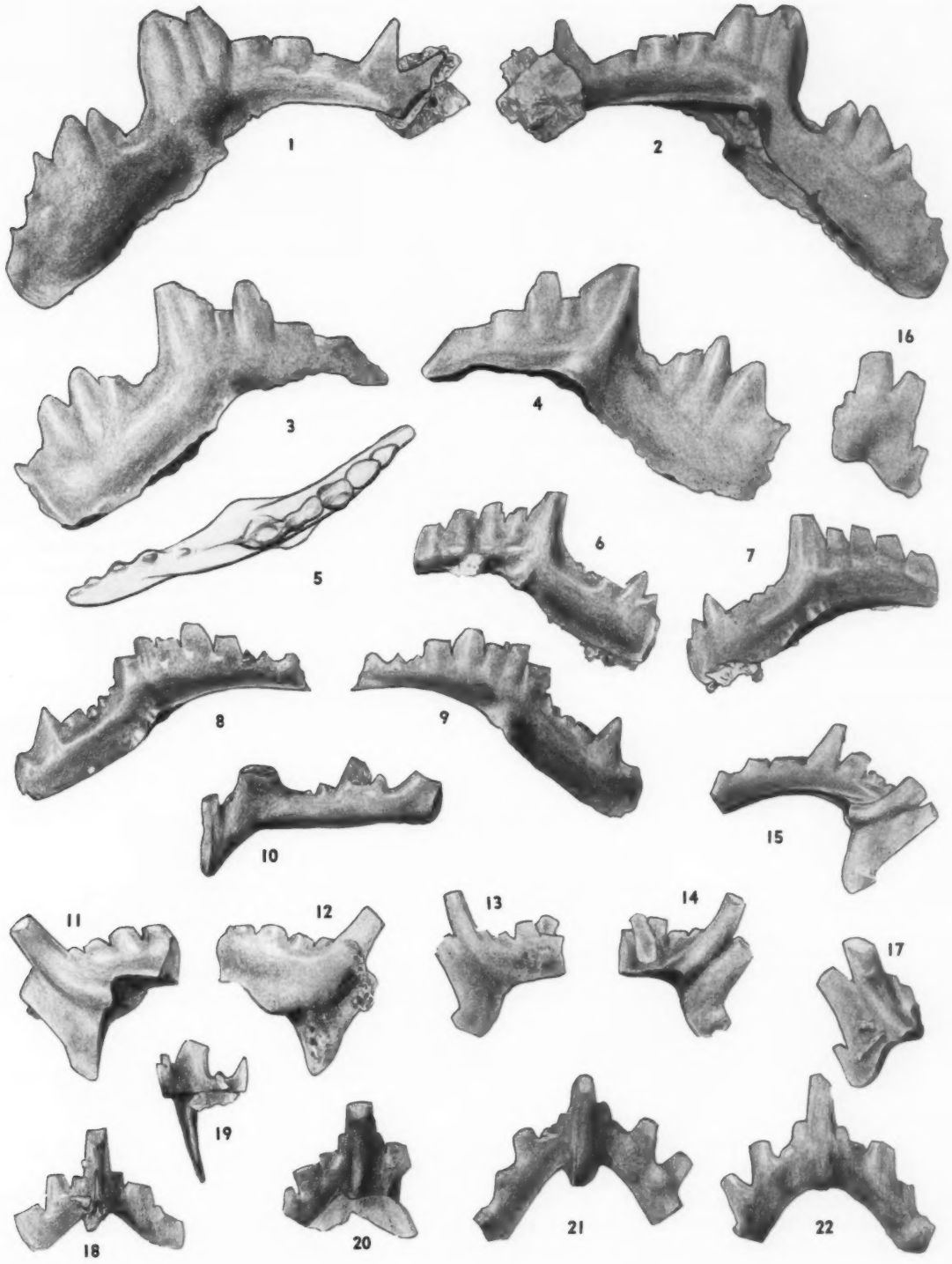
10 *Hindeodella?* sp.
Specimen no. LO 3955 t, lateral view; sample 1956.

11–14, 16–17 *Zygognathus crugensis* Lindström, n. sp.
11–12, no. LO 3956 t, two lateral views; 13–14, no. LO 3957 t, two lateral views; 16–17, no. LO 3959 t, two lateral views. All from sample 1.

15 *Zygognathus crugensis* Lindström, n. sp.
Holotype, no. LO 3958 T, showing the side with a tendency toward an undenticulated lateral process; sample 1.

18–20 *Trichonodella parabolica* Lindström, n. sp.
18–19, no. LO 3960 t, from sample 1; 18, posterior view; 19, lateral-aboral view; 20, no. LO 3961 t, from sample 2, posterior view.

21–22 *Trichonodella parabolica* Lindström, n. sp.
Holotype, no. LO 3962 T: 21, posterior view; 22, anterior view; sample 2.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Derivation of name: Superlative of Lat. *pulcher*, beautiful.

Holotype: Geol. Inst. Lund, specimen LO 3989 T (pl. 3, figs. 28–29).

Diagnosis: An asymmetrical *Prioniodina* with long, suberect cusp, with slightly twisted processes, and with the basal cavity bulging out to one side beneath the cusp.

Description: The anterior and posterior processes make an angle of 90°–120°. The anterior process is slightly shorter than the posterior one. Both processes taper rather slowly. The anterior process carries about four denticles, the posterior about six. The denticles of the two processes are about equal in size. Those of the anterior process lean strongly toward the process and are proclined or erect. Only the distal denticles are discrete. The denticles of the posterior process are all discrete, and are reclined. The denticles are compressed laterally. They are sharply pointed and have nearly straight edges. The cusp is large and erect or reclined, and tapers but slowly. Its edges are sharp. The cross section is lanceolate, widest posteriorly. The aboral margin of the unit is broadly and, on the whole, rather evenly arched. The basal cavity flares more to one side than to the other beneath the cusp. The processes are not in a plane, as the anterior process is somewhat deflected toward the side on which the basal cavity flares the most. Furthermore, the posterior process may be very slightly twisted, so that the denticles point a little outward from the side referred to. There are right and left specimens.

Occurrence: Crug limestone, in samples 1, 2, and 4; Kimmswick limestone, Missouri (Mehl and Strothman); *Climacograptus wilsoni* zone, Scotland (Lindström).

Crug material: Twenty-four specimens.

Genus PRIONIODUS Pander, 1856

Prioniodus variabilis Bergström
Plate 3, figures 17–19

Prioniodus variabilis BERGSTRÖM, MS., Geol. Fören. Stockholm, Förhandl., vol. 81 (in press, 1959).

Occurrence: Crug limestone, sample 1; *Ludibundus* limestone, Tvären, Sweden (Bergström).

Crug material: One specimen.

Genus ROUNDYA Hass, 1953

Roundya divaricata (Rhodes)
Plate 4, figures 32–33

Trichonodella divaricata RHODES, 1953, Roy. Soc. London, Philos. Trans., ser. B, vol. 237, no. 647, p. 313, pl. 21, figs. 124, 140, 145–146.

Roundya divaricata (Rhodes). – RHODES, 1955, Geol. Soc. London, Quart. Jour., vol. 111, p. 137.

Description: Only one specimen was found. The three processes all diverge at about 30°. They carry very small, irregular, laterally compressed denticles. They are continued as costae almost to the apex of the cusp. The cusp is not sharply offset from the processes. It is proclined and rather short and stout. Its cross section is subtriangular. The basal sheath extends some distance between the processes from the base of the cusp. Between the processes, the aboral margin is rather strongly arched. Toward the aboral margin, the basal sheath bulges inward rather conspicuously, otherwise the faces are smoothly convex between the processes.

Occurrence: Crug limestone, sample 1 (one specimen); Pen-y-garnedd limestone (Rhodes).

PLATE 2

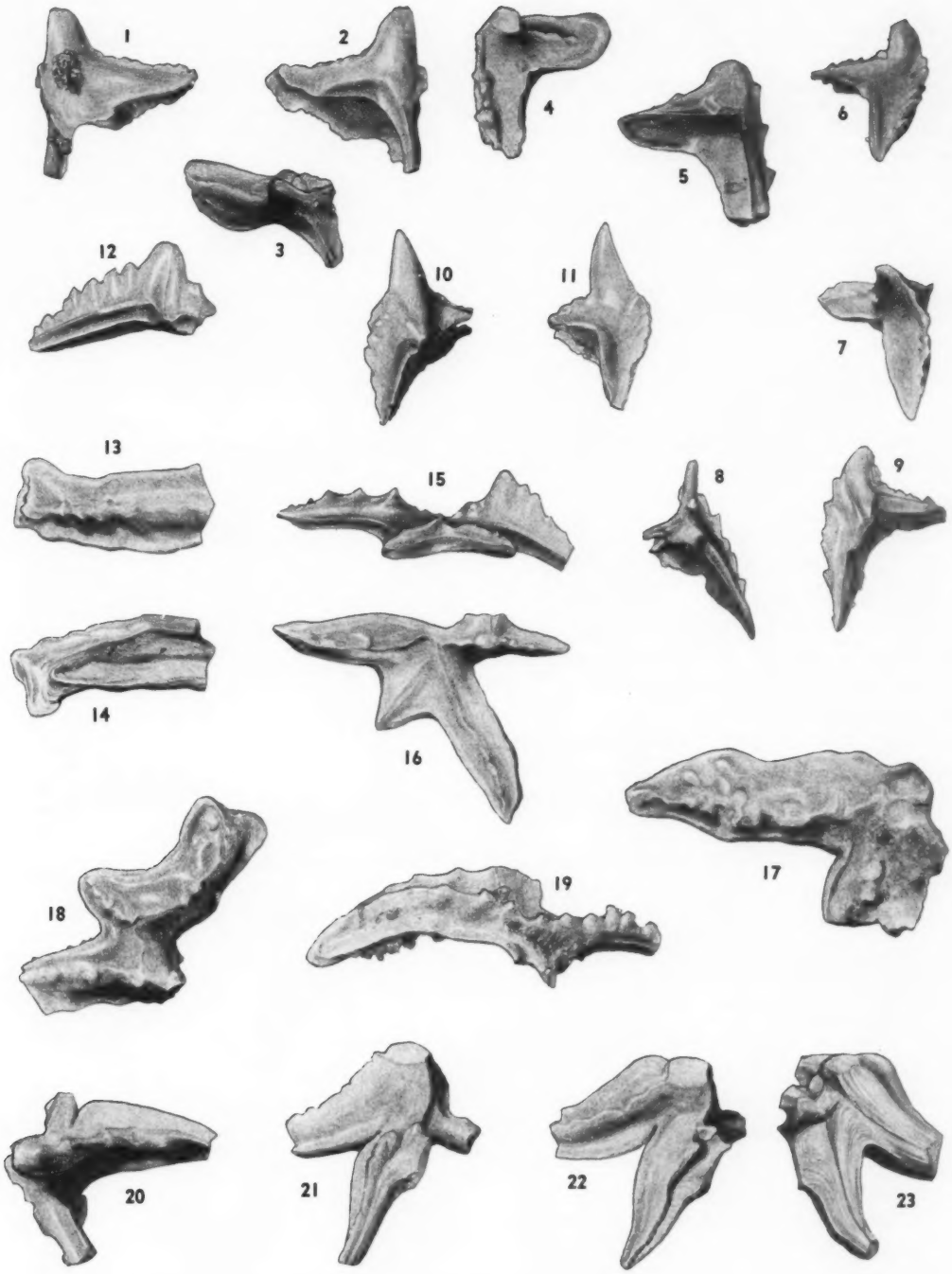
All magnifications × 65. The specimens are deposited at the Geological Institute of Lund University. All specimens are from the Ordovician (Caradocian) Crug limestone of Crug Farm, near Llandeilo, Wales.

1–11 *Ambalodus triangularis* Branson and Mehl
1–3, no. LO 3963 t: 1–2, lateral views; 3, oral view; 4–5, no. LO 3964 t, lateral views; 6–9, no. LO 3965 t: 6, 9, lateral views; 7, oral view; 8, posterior view; 10–11, no. LO 3966 t, lateral views. All from sample 1.

12–17 *Amorphognathus* cf. *ordovicica* Branson and Mehl
12, no. LO 3967 t, fragment, anterior process, lateral view, with origin of anterior lateral process; 13–14, no. LO 3968 t, fragment, posterior extremity, oral (13) and aboral (14) views; 15–16, no. LO 3969 t: 15, lateral view; 16, oral view; 17, no. LO 3970 t, fragment, posterior portion, oral view. All from sample 1.

18–19 *Amorphognathus* n. sp.
18, no. LO 3971 t, fragment, posterior lateral and part of posterior process, oral view; 19, no. LO 3972 t, specimen with broken lateral processes, oral-lateral view. Both from sample 1.

20–23 Genus and species indeterminate
20, no. LO 3973 t, from sample 3, fragment, anterior portion, oral view; 21–23, no. LO 3974 t, from sample 2, fragment, anterior portion: 21, lateral view; 22, oral view; 23, aboral view.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Roundya cf. **gracilis** (Rhodes)
Plate 4, figures 28–31

?Trichonodella gracilis Rhodes, 1953, Roy. Soc. London, Philos. Trans., ser. B, vol. 237, no. 647, p. 314, pl. 21, figs. 144, 147–150.

?Roundya gracilis (Rhodes). – Rhodes, 1955, Geol. Soc. London, Quart. Jour., vol. 111, p. 137.

Description: There is one posterior process. Two further processes are regarded as anterior, although one of them has a persistent tendency to assume a slightly more lateral position than the other. The anterior processes begin as costae well up on the cusp. They diverge by 20° or less. The posterior process diverges from the anterior processes by about 45°. In their distal portions, the processes are straight and fairly slender, not wider than the cusp. The denticles of the posterior process are suberect and very small, at most as high as the process on which they stand. There is an alternation of relatively smaller and somewhat larger denticles. The denticles of the anterior process are appressed and fused to the processes except at their apices. These denticles are almost half as wide as the cusp and several times as long as they are wide, so that they are incomparably larger than the denticles of the posterior process. The cusp is slightly curved and somewhat proclined. It is long and slender. Its cross section is oval or subrectangular. It is only slightly compressed laterally. Toward the base there is a more or less conspicuous groove on the posterior face of the cusp, and in this groove there originates the ridge that runs out on the posterior process to form its row of denticles. The basal sheath is not very extensive. It is strongly concave between the processes.

PLATE 3

All magnifications × 65. The specimens are deposited at the Geological Institute of the Lund University. All specimens are from the Ordovician (Caradocian) Crug limestone of Crug Farm, near Llandeilo, Wales.

1–5 *Drepanodus* sp.
1–2, no. LO 3975 t: 1, lateral view; 2, oral view; 3–4, no. LO 3976 t: 3, oral view; 4, lateral view; 5, no. LO 3977 t, lateral view. All from sample 1.

6–9 *Acodus similaris* Rhodes
6–7, no. LO 3978 t, lateral views; 8–9, no. LO 3979 t, lateral views. Both from sample 1.

10 *Oistodus* cf. *inclinatus* Branson and Mehl
Specimen no. LO 3980 t, lateral view; sample 1.

11–12 *Oistodus?* sp.
Specimen no. LO 3981 t, lateral views; sample 3.

13 *Oistodus* n. sp.
Specimen no. LO 3982 t, lateral view; sample 1.

14–16 *Ambalodus pulcher* Rhodes
Specimen no. LO 3983 t: 14, 16, lateral views; 15, posterior view; sample 1.

17–19 *Prioniodus variabilis* Bergström
Specimen no. LO 3984 t: 17, 19, lateral views; 18, posterior view; sample 1.

20–22 *Ambalodus elegans* Rhodes
Specimen no. LO 3985 t: 20, 22, lateral views; 21, oral view; sample 1.

23–25 *Trapezognathus?* sp.
Specimen no. LO 3986 t: 23, 25, lateral views; 24, posterior view; sample 1956.

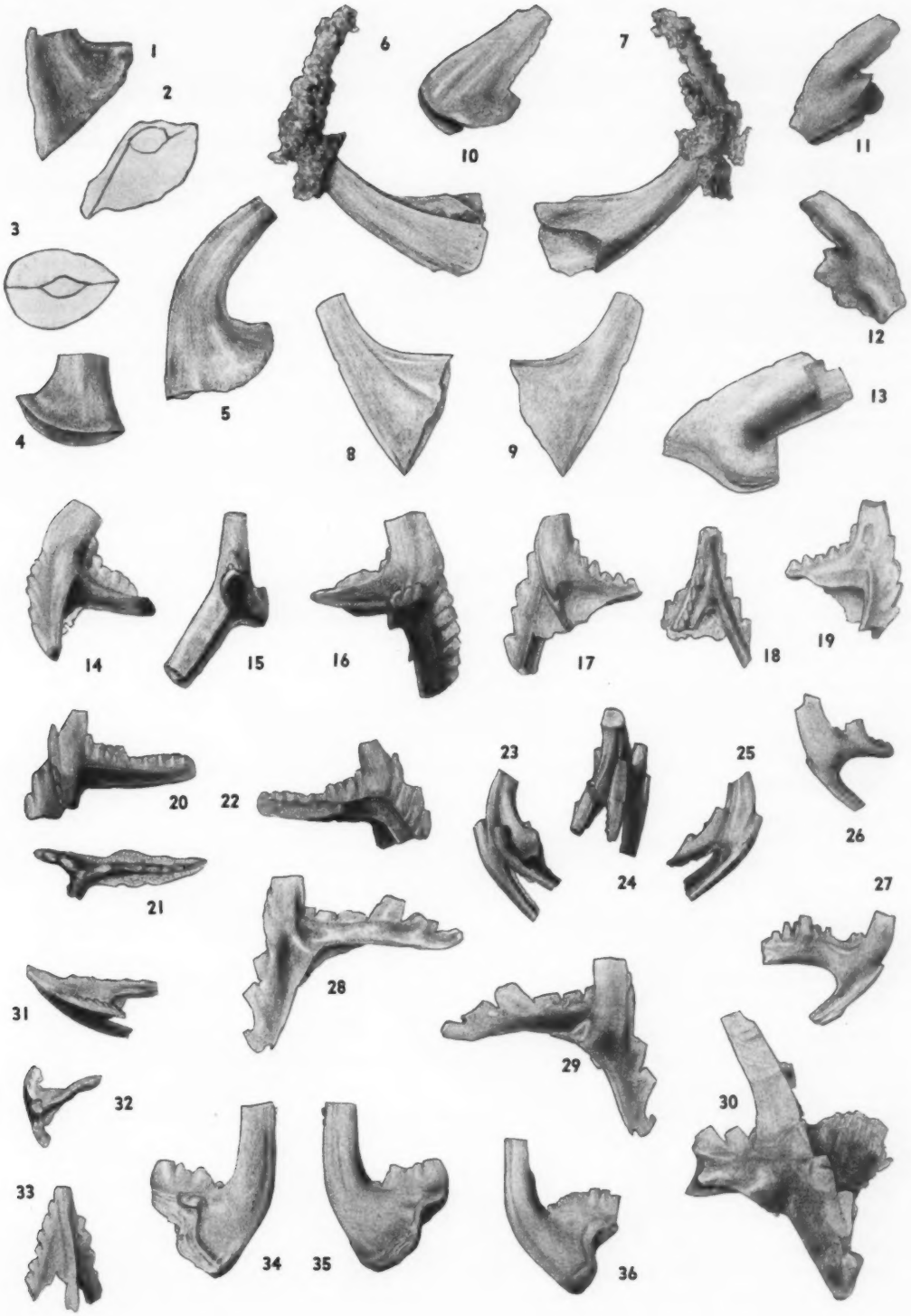
26–27 *Ligonodina elongata* Rhodes
26, no. LO 3987 t, from sample 1956, lateral view; 27, no. LO 3988 t, from sample 1, lateral view.

28–29 *Prioniodina pulcherrima* Lindström, n. sp.
Holotype, no. LO 3989 T, lateral views; sample 1.

30 *Prioniodina pulcherrima* Lindström, n. sp.
Specimen no. LO 3990 t, lateral view; sample 1.

31–33 *Roundya* sp.
Specimen no. LO 3991 t: 31, lateral view; 32, oral view; 33, posterior-oral view; sample 3.

34–36 *Cordylodus* n. sp.
34–35, no. LO 3992 t, lateral views; 36, no. LO 3993 t, lateral view. Both from sample 1.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Remarks: Roundya gracilis (Rhodes) has, according to its author, moderately large, discrete denticles on the posterior process. In the material here described, the posterior denticles are mostly small, and to some extent fused basally. Otherwise, the identity may be complete.

Occurrence: Crug limestone, samples 1–2 and 1956; (?)Gelli-grin and Pen-y-garnedd limestones (Rhodes).

Crug material: Ten specimens.

Roundya sp.
Plate 3, figures 31–33

Description: Only one specimen was found. There are three denticulate processes, two anterior and one posterior. The processes form angles of about 30° with one another. On all the processes there are small, stumpy, somewhat proclined denticles. Those of the posterior process are inconspicuous and seem to be few, whereas those of the anterior processes are somewhat larger, rather numerous, and laterally fused. The basal sheath is rather extensive. Its anterior facet is, on the whole, slightly convex, whereas the other two facets are concave. The aboral margin is rather strongly arched between the processes. The specimen may conceivably be a small *Roundya divaricata*, but it may also belong to a new species.

Occurrence: Crug limestone, sample 3 (one specimen).

Genus TRAPEZOGNATHUS Lindström, 1955

Trapezognathus? sp.
Plate 3, figures 23–25

Description: Only one specimen was found. There are four processes, two (or one) anterior, one (or two) lateral and one posterior. The species could, in fact, be looked upon as a modification of *Roundya* cf. *gracilis*, with a further lateral process developed on one side between the most anterior process and the posterior process. The description of *Roundya* cf. *gracilis* applies here, with the addition that the lateral process has large, appressed, and fused denticles of the type found on the anterior processes.

Occurrence: Crug limestone, sample 1956 (one specimen)

PLATE 4

All magnifications × 65. The specimens are deposited at the Geological Institute of Lund University. All specimens are from the Ordovician (Caradocian) Crug limestone of Crug Farm, near Llandeilo, Wales.

1–3 *Ctenognathus pseudofissilis* Lindström, n. sp.
Holotype, no. LO 3994 T: 1, 3, lateral views; 2, oral view; sample 1.

4–9 *Ctenognathus pseudofissilis* Lindström, n. sp.
4–6, no. LO 3995 t: 4, 6, lateral views; 5, oral view; 7–9, no. LO 3996 t: 7, 9, lateral views; 8, oral view. Both from sample 1.

10–16 *Icriodella superba* Rhodes
10–11, no. LO 3997 t, from sample 4, fragment, posterior process: 10, lateral view; 11, oral view; 12–13, no. LO 3998 t, from sample 3, fragment, posterior process: 12, lateral view; 13, oral view; 14–16, no. LO 3999 t, from sample 2: 14, 16, lateral views; 15, oral view.

17 *Ozarkodina pseudotypica* Lindström, n. sp.
Specimen no. LO 4000 t, lateral view; sample 1.

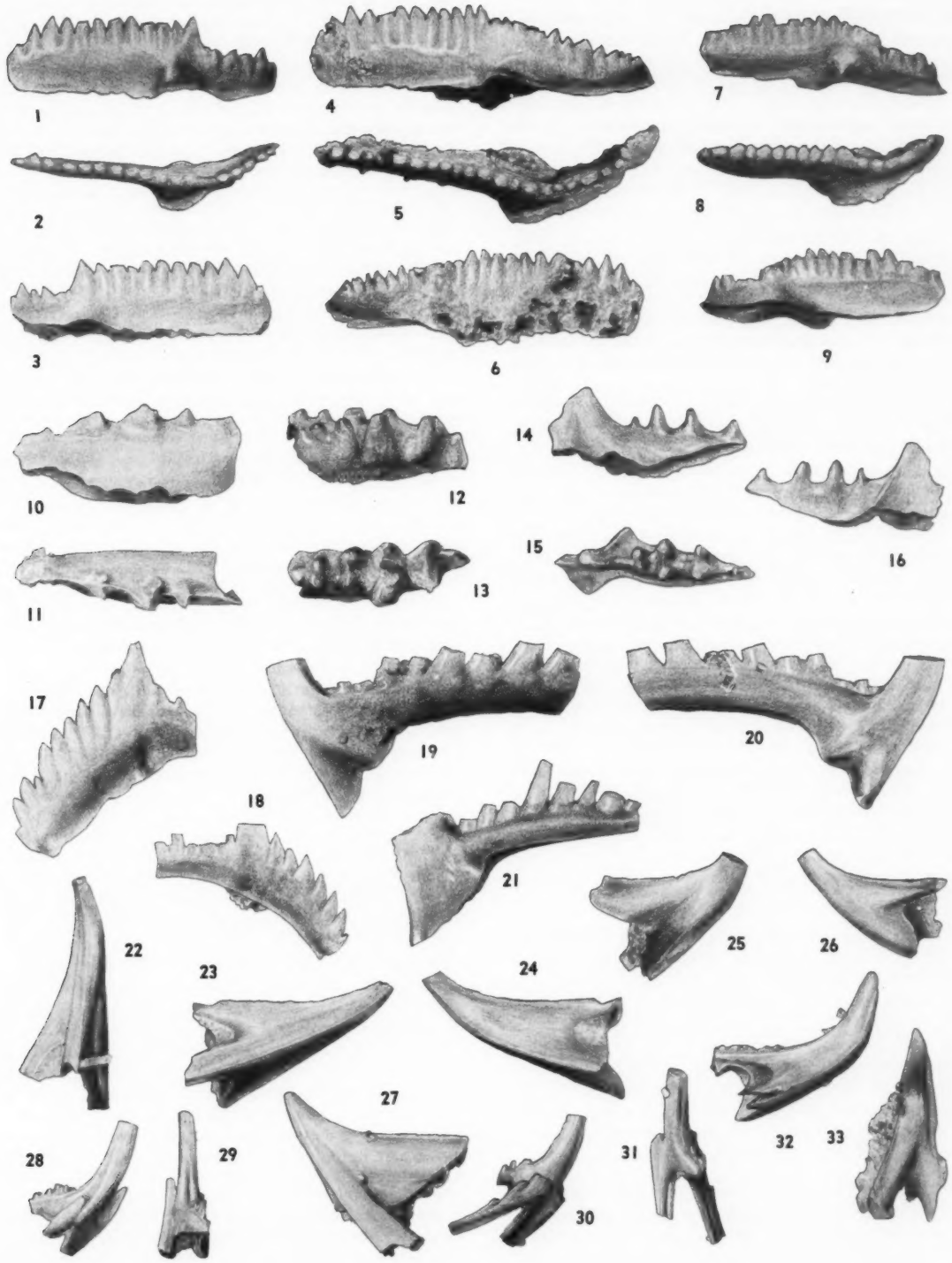
18 *Ozarkodina pseudotypica* Lindström, n. sp.
Holotype, no. LO 4001 T, lateral view; sample 1.

19–21 *Cordylodus* cf. *spurius* Branson and Mehl
19–20, no. LO 4002 t, lateral views; 21, no. LO 4003 t, lateral view. Both from sample 1.

22–27 *Acodus robustus* (Rhodes)
22–24, no. LO 4004 t, from sample 1: 22, posterior view; 23–24, lateral views; 25–26, no. LO 4005 t, from sample 2, lateral views; 27, no. LO 4006 t, from sample 1, lateral view.

28–31 *Roundya* cf. *gracilis* (Rhodes)
28–29, no. LO 4007 t, from sample 1956: 28, lateral view; 29, posterior view; 30–31, no. LO 4008 t, from sample 1: 30, lateral-anterior view; 31, posterior view.

32–33 *Roundya divaricata* (Rhodes)
Specimen no. LO 4009 t: 32, lateral view; 33, oral-posterior view; sample 1.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Genus TRICHONODELLA Branson and Mehl, 1948

Trichonodella parabolica Lindström, **new species**
Plate 1, figures 18–22

?Trichonodella flexa Rhodes. – GLENISTER, 1957, Jour. Pal., vol. 31, no. 4, p. 734, pl. 88, fig. 13.

Derivation of name: From the parabola described by the aboral margin of the anterior processes.

Holotype: Geol. Inst. Lund, specimen LO 3962 T (pl. 1, figs. 21–22).

Diagnosis: A *Trichonodella* with the arched anterior processes making an angle of 60°–90°, each process having about five rather discrete denticles. Cusp rather slender.

Description: The unit is symmetrical or nearly so. It has one posterior and two anterior processes. (The term anterior processes should be unambiguous. In Lindström (1955*a*), they were referred to as anterior lateral processes, but in the present paper, the term anterior lateral process is used as opposed to posterior lateral process in the genus *Amorphognathus*.) The posterior process is very short and seems mostly to lack denticles. Only two of the specimens have denticles on the posterior process. The anterior processes are large and bear denticles. Roughly speaking, they lie in one plane. They are somewhat arcuate. Proximally they form an angle of more than 90°. In the larger specimens the angle that the distal ends of the anterior processes make with one another is considerable less than 90°. The cusp is recurved, lying out of the plane of the anterior processes. Its cross section is ovoid or subrectangular. Anteriorly, it is almost level with the anterior face of the anterior processes. It is all the more prominent posteriorly. Its posterior face is somewhat flattened and smooth, or is provided with a thin posterior crest, on each side of which there runs an inconspicuous groove, or there may be only a barely discernible longitudinal groove instead of a crest. The posterior "edge" of the cusp, as thus defined, may be somewhat displaced laterally, which makes the unit slightly asymmetrical. The base of the cusp is drawn out posteriorly into the small posterior process.

The larger specimens may bear four or five denticles on each of the anterior processes. These denticles are somewhat flattened anteroposteriorly, but may be almost as wide as the cusp in a lateral direction. They are suberect, diverging slightly in the plane of the anterior processes. They are discrete, except for one or two smaller denticles next to the cusp. In two specimens, the posterior process carries one or two very small denticles, which, in one specimen (pl. 1, fig. 19), can be seen to be erect, discrete, thin, and pointed. In other cases, there appear to have been no posterior denticles.

The basal cavity is deep beneath the cusp, and flares posteriorly. There may also be a suggestion of a bulge on the anterior face of the unit, at the base of the cusp. The extensions of the cavity along the anterior processes are rather shallow and constricted. In one specimen (pl. 1, fig. 20), a very thin lamella of colourless transparent material projects beyond the basal sheath. This transparent additional lamella is obviously not a direct continuation of the ordinary basal sheath, but extends into the basal cavity, where it forms a kind of lining. This can be inferred from the right-hand portion of the figure, which shows that the transparent lamella in question is intact, whereas most of the anterior process has been broken away.

Remarks: The species differs from *Trichonodella flexa* Rhodes in that the arch formed by the processes is broader and the cusp is not sharp-edged. The rather similar *Trichonodella tenuis* (Branson and Mehl) has a greater number of denticles, which, furthermore, are confluent at their bases. *Trichonodella recurva* (Branson and Mehl) has a stouter cusp as compared with the denticles, and a more sharply arched aboral margin. In *Trichonodella minnesotensis* (Stauffer), the angle made by the anterior processes is considerabley smaller than in my species.

Occurrence: Crug limestone, samples 1–3; (?)Maquoketa formation, Iowa (Glenister).

Crug material: Twenty-seven specimens.

Genus **Zygognathus** Branson, Mehl and Branson, 1951

Remarks: If the genus *Trichonodella* is restricted to rather symmetrical forms, in which the denticulated processes are regarded as anterior, and the genus *Gyrognathus* is defined as possessing only two processes, without a lateral flare that may be a hint of an undenticulated lateral process, then the present genus can be regarded as intermediate between the two, as an asymmetrical *Trichonodella* or a *Gyrognathus* with an undenticulated lateral process or flare.

The general plan of *Zygognathus* seems to be the same as that of *Lonchodina*, as generally dealt with and as defined by the drawing (text-fig. 9, p. 67) in Bischoff and Ziegler (1957). However, *Lonchodina* may be defined in a useful way, and in accordance with its type species, by referring to the very long and discrete denticles of these seemingly post-Ordovician forms. Good examples of forms with very long, discrete denticles are, among others, *Lonchodina paraclarki* Hass, 1953 (pl. 16, fig. 15), *L. separata* Branson and Mehl, 1933 (pl. 15, fig. 16), and *L. ramulata* Bischoff and Ziegler, 1957 (pl. 10, fig. 1). On the other hand, several Ordovician species, including those assigned to *Zygognathus* by Branson, Mehl and Branson, 1951, have the plan ascribed to *Zygognathus* in the preceding description, but differ from *Ligonodina* in having relatively short and not quite discrete denticles, which taper rapidly to a point.

I am indebted to Professor W. C. Sweet, of The Ohio State University, for very valuable advice concerning *Zygognathus*.

Zygognathus crugensis Lindström, **new species**
Plate 1, figures 11–15; text-figure 3:5

Derivation of name: After the Crug Farm locality.

Holotype: Geol. Inst. Lund, specimen LO 3958 T (pl. 1, fig. 15).

Diagnosis: A *Zygognathus* with several denticles on the posterior process but as a rule only two on the anterior, the foremost of these two denticles being quite small, but the one next to the cusp being large and as wide as the cusp.

Description: The denticulated processes make an angle of somewhat more than 90° where they meet. The anterior process is shorter than the posterior process. The latter is broken at the end in all the specimens. The anterior process is nearly straight, whereas the posterior process is arcuate. The cusp and the denticles are proclined. The cusp is rather long and slender, with a rounded cross section. Its anterior and posterior edges are inconspicuous. The denticles are more flattened laterally. The anterior process as a rule does not carry more than two denticles. The denticle next to the cusp on the anterior process is as wide as the cusp or somewhat wider. The denticles on the posterior process are rather large and subequal in size. The basal cavity is shallow along the processes but is fairly deep at the base of the cusp.

The species is markedly asymmetrical. The denticles, and especially the cusp, are curved toward one side, so that one side of the unit is convex and the other concave. The cusp is the most strongly rounded on the concave side of the unit. On that side, it is also continued down on the basal sheath, to the aboral margin, by a conspicuous bulge of the sheath. On the other (convex) side of the unit, the corresponding position on the basal sheath is occupied by a slight depression. The strongly rounded side of the cusp is turned slightly backward. Both right and left specimens have been found.

Remarks: The characteristic denticles on the anterior process set the species apart from other species of the genus. The new species resembles *Zygognathus planus* (Stauffer, 1935*b*, pl. 71, fig. 36), in which, however, the foremost denticle seems to be larger, and the denticles of the posterior process more discrete, than in the present species.

Occurrence: Crug limestone, samples 1 and 2.

Material: Seventeen specimens.

Genus and species indeterminate
Plate 2, figures 20–23

Description: Only fragments are available. Most of the posterior portion is unknown. The anterior process is nearly, but not quite, straight in oral view, and straight in side view. Its median crest is composed of a number of not too clearly distinguishable, fused, somewhat irregular denticles that increase in size posteriorly. The cusp is thick and rather blunt, with a rounded cross section. It carries costae that run out on the processes. The anterior lateral process and the posterior lateral process are situated on opposite sides, the anterior on the flank of the cusp. The anterior lateral process is deeply divided into two lobes that are about as big as the anterior process and have the same elongate tongue-shape. The anterior lateral process dips away in the aboral direction. Its median crest is rather low, and carries small, fused denticles. The posterior lateral process is only preserved in part, in one specimen. To judge from the angle that its anterior margin makes with the anterior process, it is not bilobate. The oral surface of the ledge that runs along the processes is rather wide and nearly flat or slightly concave. It is ornamented by small but rather conspicuous densely spaced shallow pits. The aborally turned part of the ledge is not very wide. The basal cavity is rather wide but shallow or may even have a tendency toward eversion.

Remarks: The specimens may belong to a species of *Amorphognathus*, but as the posterior part is unknown, it is best to leave that question open until more complete specimens are found.

Occurrence: Crug limestone, in samples 2, 3, and 1956.

Material: Three specimens.

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ABSTRACT: *The present work is a biostratigraphic study of the Maestrichtian, Danian, and Montian formations and their microfaunas in Gabal Um Elghanayem of the Western Desert of Egypt. The* Echinocorys *chalk, with a typical Danian macrofauna, is flooded with* Globorotalia *of the* simulatilis-velascoensis *group and with other members of the* Globorotalia *zone microfauna.*

Biostratigraphy of the Um Elghanayem section, Egypt

S. E. NAKKADY
University of Assiut
Assiut, Egypt

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LOCATION

Gabal Um Elghanayem is a conspicuous hill in the Kharga Oasis of the Western Desert of Egypt, about 275 meters above sea level and about 300 meters high. It lies approximately at latitude 25°35′ North and longitude 30°44′ East.

STRATIGRAPHY

The sequence of strata in the hill is as follows (from top to bottom):

	Thickness in meters
7) *Nummulites* and *Operculina* limestone, of Montian (s. l.) age, rich in archaic *Nummulites*, such as *Nummulites deserti* and in *Operculina libyca*, *Lucina thebaica*, and *Conoclypeus delanoue*	94
6) Upper Esna shales, of Danian age; greenish to greyish, devoid of macrofossils	44
5) *Echinocorys* chalk, of Danian age; white chalk and chalky limestone, with *Echinocorys ovatus* and *Schizorhabdus libycus*	20.5
4) Lower Esna shales, of Danian age; clays and shales with many small gastropods and lamellibranchs, of which the most abundant are *Nucula khargensis*, *Leda leia*, *Alaria schweinfurthi*, *Natica farafrensis*, and *Pecten farafrensis;* also rich in *Nautilus desertorum*, *Nautilus danicus*, and *Schizorhabdus libycus*	32
3) *Cardita* beds, of Danian age; yellowish and grey limestones with clay intercalations, with many specimens of *Cardita*	9.5
2) *Exogyra overwegi* beds, of Maestrichtian age; clays, shales, and marls with intercalated sandstones, characterized by *Isocardia khargensis* near the base and *Exogyra overwegi* beds near the top	40
1) Nubian "sandstone"; typically without megafossils; sandstones of unknown downward extent with intercalated shales, passing upward into the clays and phosphate beds of the overlying formations; observed to	60

FAUNAL DISTRIBUTION AND AGE OF THE FORMATIONS

The Nubian "sandstone"

The argillaceous intercalations within the formation have yielded a microfauna that appears to suggest an age for them in this area. Arranged according to their relative frequencies, the important elements are as follows: Coprolites of echinoids, *Neobulimina khargensis*, *Buliminella carseyae*, *Gaudryina pyramidata*, *Cibicides abudurbensis*, *Globigerina esnaensis*, *Globigerina quadrata*, *Nodosaria zippei*, *Siphogenerinoides oveyi*, *Globotruncana aegyptiaca*, *Anomalina pseudoacuta*, *Anomalina umbonifera*, and *Gyroidina aegyptiaca*. The distribution of these forms is shown in chart 1.

Consideration of the ranges of this fauna in Egypt and in other regions seems to favor a Maestrichtian age for this part of the formation. Most of the forms have a Campanian-Maestrichtian range, but *Siphogenerinoides oveyi* is known only from the upper Maestrichtian and basal Danian.

The Exogyra overwegi beds

Most of the scanty Nubian fauna survived the oncoming of the deeper environment of the *Exogyra* shales. The most outstanding member of the new elements in this formation is *Ammobaculites khargensis*; to a lesser degree *Guembelina reussi* and *Globotruncana quadrata* are also prominent. Frequent specimens of *Globigerina* (group of *G. triloculinoides* Plummer) made their first appearance in these deposits, before flooding the overlying Danian layers. The upper limit of the *Exogyra* beds coincides with the line marking the last survivors of the meager *Globotruncana* fauna, and it is at this line that the Cretaceous-Tertiary boundary is drawn. Apart from *Siphogenerinoides oveyi* and *Globotruncana aegyptiaca*, other members of the Cretaceous fauna continue with the same frequency, leaving no doubt concerning the paleontological continuity between the two systems in this particular section.

The Cardita beds

The only difference between the fauna of these beds and that of the underlying *Exogyra* layers is the absence of *Globotruncana* and the first appearance of species of *Globigerina* of the *G. pseudobulloides* type.

The lower Esna shales

The fauna continues with the same pattern to the upper layers of the lower Esna shales, which are distinguished by the first appearance, or great abundance, of certain important forms: *Anomalinoides* of the *danicus* group, *Cibicides multifarius*, *Anomalina pseudoacuta*, *Globigerina triloculinoides*, *Globigerina quadrata*, *Globigerina pseudobulloides*, *Gyroidina aegyptiaca*, *Valvulineria brotzeni*, *Rotalia rigida*, *Alabamina midwayensis*, *Bolivina daniana*, *Verneuilina cretacea*, *Gaudryina textulariformis*, *Gaudryina austinana*, *Spiroplectammina carinata*, and *Ammobaculites khargensis*.

The foraminiferal assemblage of the *Cardita* beds and lower Esna shales indicates a Danian age. They fall within the "buffer zone" between the last survivors of the Maestrichtian *Globotruncana* and the first flooding of *Globorotalia* in the succeeding *Echinocorys* chalk.

The Echinocorys chalk

In the present section, the chalk has a microfauna of special interest and of typical Tertiary character. It contains *Globorotalia* species of the *simulatilis-velascoensis* type, and *Globigerina* species of the *pseudobulloides-triloculinoides* group, whereas the lithologically and stratigraphically analogous formations in the other Egyptian areas hitherto studied have yielded a decidedly older microfauna, mostly Cretaceous in age.

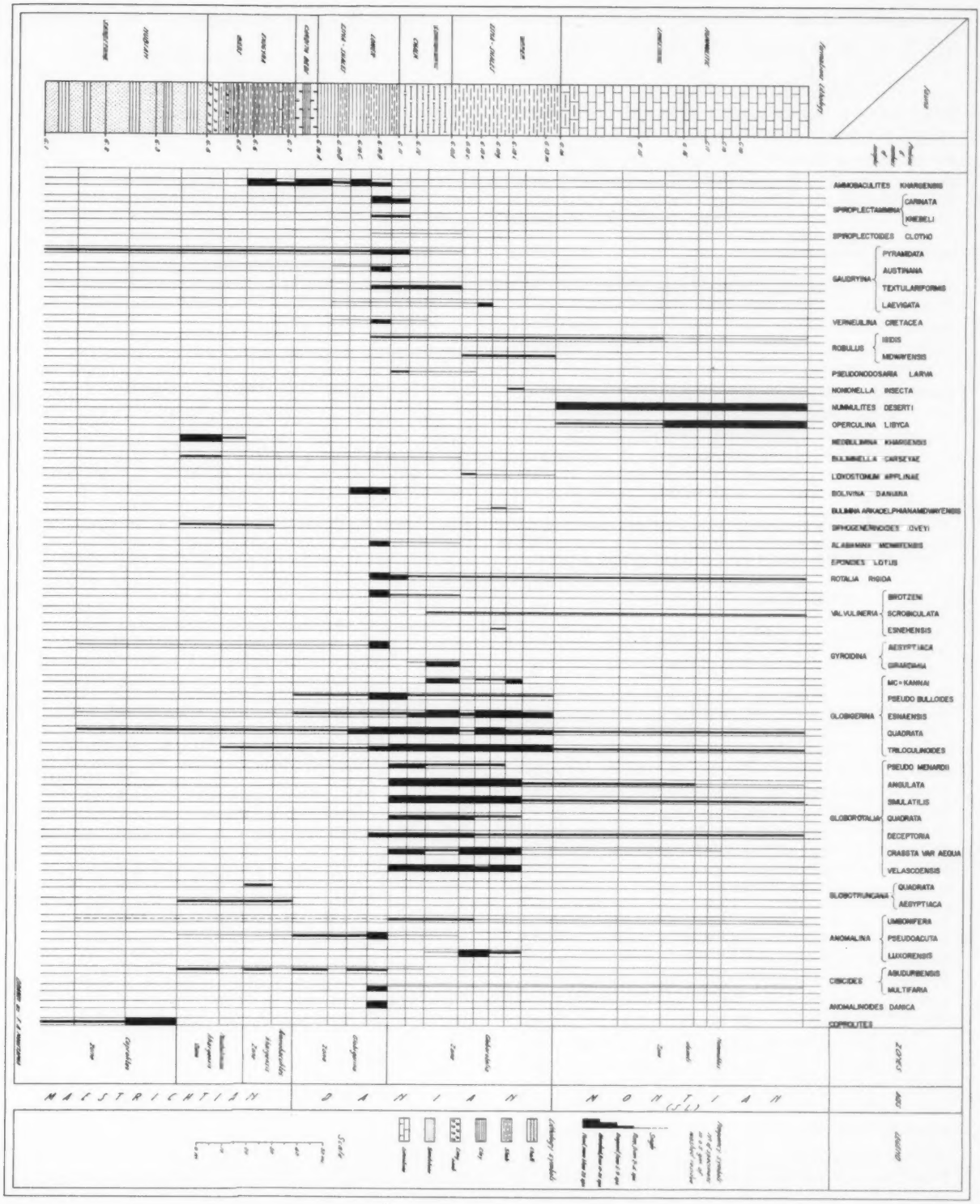
The flooding of *Globorotalia* species of the *simulatilis-velascoensis* group in this formation signifies that the age of this important horizon, which has hitherto been questionable, is Danian (see Nakkady, 1957).

The apparent retardation of this *Globorotalia* horizon in certain areas in Egypt should not negate its constancy or regularity, or be interpreted as a peculiarity in the vertical ranges of this stratigraphically important group. Its explanation does not demand a resort to the fictional speculation that deposition took place in deep troughs, or over orogenically formed ridges, as proposed by Said and Kenawy (1956). The variation in thickness of the "buffer" or *Globigerina* zone, or, in other words, variation in the appearance of *Globorotalia* in the various sections examined, is negligible compared with the geographic distances between these sections. A difference of a few meters in thickness between one section and another could be due merely to simple undulations in the early Tertiary sea bottom, or to local deep currents retarding continuous deposition and moving accumulated sediments temporarily from the areas that appear at present to have thinner "buffer" sediments.

The more important forms of the *Echinocorys* chalk microfauna are *Spiroplectammina carinata*, *Spiroplectammina knebeli*, *Gaudryina pyramidata*, *Gaudryina textulariformis*, *Robulus isidis*, *Bolivina daniana*, *Rotalia rigida*, *Gyroidina girardana*, *Globigerina pseudobulloides*, *Globigerina esnaensis*, *Globigerina quadrata*, *Globigerina triloculinoides*, *Globorotalia pseudomenardii*, *Globorotalia angulata*, *Globorotalia simulatilis*, *Globorotalia quadrata*, *Globorotalia crassata* var. *aequa*, *Globorotalia velascoensis*, *Anomalina umbonifera*, and *Cibicides multifarius*.

The upper Esna shales

The more conspicuous forms of the *Echinocorys* chalk pass without a break into the overlying upper Esna shales. However, certain chalk-preferring forms did not survive in the new shaly environment. *Verneuilina cretacea*, *Bolivina daniana*, and *Gaudryina pyramidata* were not found in the shales, although some other interesting forms make their first appearance. They are *Loxostomum applinae*, *Valvulineria scrobiculata*, *Globigerina mckannai*, and *Anomalina luxorensis* Nakkady (pl. 5, fig. 1a–c). The Esna shale fauna continues more or less in this pattern up to the basal layers of the *Nummulites* and *Operculina* limestone, but with the absence of arenaceous forms, a noticeable decline in *Globigerina pseudobulloides*, and a generally lower frequency of Globigerines and Globorotalias. The age of this formation, from the top of the chalk to the first appearance of *Nummulites*, is Danian.


AMMOBACULITES KHARGENSIS
SPIROPLECTAMMINA CARINATA
KHEBELI
SPIROPLECTOIDES CLOTHO
GAUDRYINA PYRAMIDATA
AUSTINANA
TEXTULARIFORMIS
LAEVIGATA
VERNEUILINA CRETACEA
ROBULUS IRIDIS
MEDWAYENSIS
PSEUDONODOSARIA LARVA
NONIONELLA INSECTA
NUMMULITES DESERTI
OPERCULINA LIBYCA
MEDDELLINNA KHARGENSIS
BULIMINELLA CARSEYAE
LOXOSTOMUM APPLINAE
BOLIVINA DANUBIA
BULIMINA ARKADELPHIANAMEDWAYENSIS
EPONIDES LOTUS
ROTALIA RIGIDA
VALVULINERIA BROTZENI
SCROBICULATA
ESNEHENSIS
GYROIDINA AEGYPTIACA
GIRARDANA
GLOBIGERINA MC=KANNAI
PSEUDO BULLOIDES
ESNAENSIS
QUADRATA
TRILOCULINOIDES
GLOBOROTALIA PSEUDO MENARDII
ANGULATA
SIMULATILIS
QUADRATA
DECEPTORIA
CRASSTA VAR AEQUA
VELASCOENSIS
GLOBOTRUNCANA QUADRATA
AEGYPTIACA
ANOMALINA UMBONIFERA
PSEUDOACUTA
LUXORIENSIS
CIBICIDES ABUDURBENSIS
MULTIFARIA
ANOMALINOIDES DANICA
COPROLITES
MAESTRICHTIAN
D A N I A N
N O N T I A N

The Nummulites limestone

This formation is flooded with *Nummulites deserti* de la Harpe (pl. 5, fig. 3a–c), together with a meager part of the *Globigerina-Globorotalia* fauna of the underlying shales. It can be assigned a Montian (s.l.) age (Nakkady, 1957), and is easily distinguished from the underlying shales by the explosive appearance of *Nummulites* that took place in the shoaling, regressing calcareous sea.

SYSTEMATIC PALEONTOLOGY

A systematic study of the important elements of the foraminiferal fauna occurring in the Um Elghanayem section follows. The new species are described jointly with M. Y. Talaat. The new or particularly important species, and those that have not been previously discussed by the writer, are illustrated.

Order Foraminifera

Family Lituolidae

Genus Ammobaculites Cushman, 1910

Ammobaculites khargensis Nakkady and Talaat, **new species**
Plate 6, figures 1a–b, 2a–b

Description: Test strongly compressed, subcircular to subelliptical in the early stages. Peripheral outline sometimes lobulate; about two whorls make up the test, the outer one, of eight to ten chambers, occupying about three-fourths of the size. Early chambers close-coiled, later ones tending to uncoil, and in a few specimens the last two or three even becoming rectilinear. Sutures usually indistinct, but when the specimen is moistened, they appear as straight or slightly curved thin bands of different color from that of the shell material. Wall arenaceous, of subangular quartz grains, rather smoothly finished, mostly of whitish or cream color, rarely reddish. Aperture a small triangular opening at the base of the last septal face of the last chamber.

Remarks: The nearest congeneric form to the present species is *Ammobaculites expansus* Plummer, which appears to have a coarser, more roughly finished wall, of dark metallic to reddish color, and a different position and shape of the aperture.

Distribution: Ammobaculites khargensis appears first in the *Exogyra overwegi* beds, flooding the fauna in the upper layers; it is a conspicious element in all of the succeeding strata up to the end of the lower Esna shales, where it abruptly vanishes.

Holotype: Length 0.89 mm.; breadth 0.62 mm.; thickness 0.19 mm.; selected from sample G.6 and deposited in the U.S. National Museum, Washington, D.C.

Family Textulariidae

Genus Spiroplectammina Cushman, 1927

Spiroplectammina carinata (d'Orbigny)
Plate 1, figure 1a–b

Textularia carinata d'Orbigny, 1846, Foram. foss. Bass. Tert. Vienne, p. 247, pl. 14, figs. 32–34.
Spiroplectammina esnaensis LeRoy, 1953, Geol. Soc. Amer., Mem. 54, p. 50, pl. 1, figs. 11–12 (holotype, Cushman Coll., no. 58024).
Spiroplectammina dentata (Alth).—Said and Kenawy, 1956, Micropaleontology, vol. 2, no. 2, p. 121, pl. 1, fig. 9 (holotype, U.S.N.M., no. P. 3948).
Spiroplectammina paracarinata Said and Kenawy, 1956, Micropaleontology, vol. 2, no. 2, p. 122, pl. 1, fig. 13 (holotype, U.S.N.M., no. P.3987).

Description: Test compressed, oval or triangular in outline; early coiled stage small, sutures variable in character, slightly depressed, flush with the surface or slightly raised, inclined or slightly curved. Side flanges also variable in width and shape. Aperture typically textularian, at the base of the last chamber. The wide range of variation exhibited by large populations of this species includes the synonyms listed above.

Distribution: In the present section the species is best developed in the Danian upper layers of the lower Esna shales and in the basal beds of the *Echinocorys* chalk.

Genus Spiroplectoides Cushman, 1927

Spiroplectoides clotho (Grzybowski)
Plate 1, figure 2a–b

Spiroplecta clotho Grzybowski, 1901, Akad. Umiej. Krakow. Wydz. Mat.-Przyr., Rozpr., vol. 41, p. 283, pl. 7, fig. 18,
Bolivinopsis? clotho (Grzybowski).—Cushman, 1946, U. S. Geol. Survey, Prof. Paper no. 206, p. 103, pl. 44, fig. 11.

Description: Test siliceous, elongate, somewhat compressed, parallel-sided. Initial planispiral part occupying one-sixth of length of test. Sutures in biserial stage slightly depressed, limbate, and highly inclined. About twelve chambers make up the biserial stage; they are almost as broad as high. Aperture small, elliptical, at the base of the last-formed chamber.

Distribution: Rare from the top of the lower Esna shales to the base of the upper Esna shales; Danian.

Family Verneuilinidae

Genus Verneuilina d'Orbigny, 1840

Verneuilina cretacea Karrer
Plate 1, figure 3a–b

Verneuilina cretacea Karrer, 1870, Austria, Geol. Reichsanst., Jahrb., vol. 20, p. 164, pl. 1, fig. 1.
Verneuilina bronnii Reuss.—White, 1928, Jour. Pal., vol. 2, p. 299, pl. 42, fig. 3.

Verneuilina aegyptiaca SAID AND KENAWY, 1956, Micropaleontology, vol. 2, no. 2, p. 122, pl. 1, fig. 16 (holotype, U.S.N.M., no. P.3954).

Verneuilina karreri SAID AND KENAWY, 1956, Micropaleontology, vol. 2, no. 2, p. 122, pl. 1, fig. 17 (holotype, U.S.N.M., no. P.3955).

Remarks: *Verneuilina cretacea* shows a wide range of variation in the character of its edges, both rough and rounded forms being present, as well as in the size and length of the test. The two forms described by Said and Kenawy should not be separated from the present species.

Distribution: In the present material *Verneuilina cretacea* is confined to the upper layers of the lower Esna shales and the *Echinocorys* chalk.

Genus GAUDRYINA d'Orbigny, 1839

Gaudryina austinana Cushman
Plate 1, figure 4a–b

Gaudryina austinana CUSHMAN, 1936, Cushman Lab. Foram. Res., Spec. Publ. no. 6, p. 10, pl. 2, fig. 6a–b; 1946, U.S. Geol. Survey, Prof. Paper no. 206, p. 35, pl. 8, figs. 5–7 (holotype, Cushman Coll., no. 19556).

Description: Test elongate, about two or three times longer than broad, the early triserial portion triangular, occupying about one-third of the length of the test; the later biserial portion quadrangular because of the formation of a fourth keel, extending from the edge of the top part of the test downward to join, in some cases, the nearest opposite keel of the triangular portion of the test. Angles sharp or slightly rounded in the later biserial part. Sutures in the triserial part oblique, scarcely visible, flush with the surface; those in the biserial part slightly inclined and markedly depressed. Wall arenaceous, rather smoothly finished. Aperture conspicuous, in a re-entrant at the inner margin of the last-formed chamber.

Distribution: In the present material the species is known from the younger beds of the Danian lower Esna shales.

Gaudryina textulariformis Nakkady and Talaat, **new species**
Plate 6, figure 3a–d

Description: Test short, about one to one and one-half times as long as broad, tapering to the blunt initial end, the greatest breadth formed by the last two chambers. Early triserial portion very small, very difficult to see in many specimens except after sectioning. Chambers and sutures are most indistinct in this part. Later biserial portion ovate in cross section, composed of about four sets of distinct, rather inflated chambers, the last two of which are oval and markedly large. Sutures in this part are deep, slightly inclined or feebly arched. Wall smoothly finished, with much calcareous cement. Aperture a low arched opening at the base of the last chamber.

Remarks: *Gaudryina textulariformis* can be distinguished from the similar *Gaudryina modica* Bermudez, of the Lower Eocene of Haiti, by its smaller size and the characteristic saucer-like shape of its last two chambers.

Distribution: Abundant from the top sample of the lower Esna shales to the uppermost beds of the *Echinocorys* chalk.

Holotype: Length 0.31 mm.; breadth 0.26 mm.; selected from sample G.12 and deposited in the U.S. National Museum, Washington, D.C.

Gaudryina laevigata Franke
Plate 1, figure 5a–b

Gaudryina laevigata FRANKE, 1914, Deutsch. Geol. Ges., Zeitschr., vol. 66, no. 3, p. 431, pl. 27, figs. 1–2.

Description: Test elongate, triangular in cross section with sharp edges and indistinct, inclined sutures in the early triserial portion. Biserial portion with subacute angles, distinct chambers, and markedly depressed and inclined sutures. Aperture circular or elongate, near the base of the last chamber.

Distribution: Specimens apparently identical with Franke's types are present throughout the middle Danian layers of the present section.

Gaudryina pyramidata Cushman
Plate 1, figure 6a–b

Gaudryina laevigata Franke var. *pyramidata* CUSHMAN, 1926, Amer. Assoc. Petr. Geol., Bull., vol. 10, p. 587, pl. 16, fig. 8 (holotype, Cushman Coll., no. 5149).

Gaudryina pyramidata Cushman. – LEROY, 1953, Geol. Soc. Amer., Mem. 54, p. 31, pl. 1, figs. 17–18 (hypotype, Cushman Coll., no. 58105).

Gaudryina aissana ten Dam and Sigal. – SAID AND KENAWY, 1956, Micropaleontology, vol. 2, no. 2, p. 123, pl. 1, fig. 20 (holotype, U.S.N.M., no. P.3958).

Gaudryina limbata SAID AND KENAWY, 1956, Micropaleontology, vol. 2, no. 2, p. 123, pl. 1, fig. 23 (holotype, U.S.N.M., no. P.3961).

Gaudryina soldadoensis Cushman and Renz. – SAID AND KENAWY, 1956, Micropaleontology, vol. 2, no. 2, p. 124, pl. 1, fig. 27 (hypotype, U.S.N.M., no. P.3965).

Gaudryina nekhlensis SAID AND KENAWY, 1956, Micropaleontology, vol. 2, no. 2, p. 124, pl. 1, fig. 24 (holotype, U.S.N.M., no. P.3962).

Remarks: Examination of large populations of this species from this section and from other sections in Egypt and abroad reveals all of the characters of *Gaudryina pyramidata*, which also includes the forms established as new by Said and Kenawy.

Distribution: In Um Elghanayem the species ranges from the Maestrichtian to the middle Danian, but is best developed in the Danian lower Esna shales and *Echinocorys* chalk.

Family LAGENIDAE

Genus ROBULUS Montfort, 1808

Robulus midwayensis (Plummer)
Plate 1, figure 7a–b

Cristellaria midwayensis PLUMMER, 1927, Texas Univ. Bull. 2644, p. 95, pl. 13, fig. 5.

Remarks: The Egyptian specimens agree well with Plummer's types and with the large collection of specimens examined at the U. S. National Museum. The test is moderately compressed, showing a pronounced umbo, nine chambers, and moderately elevated sutures, which expand slightly near the narrowly flanged periphery.

Distribution: Upper Danian, in the higher beds of the upper Esna shales.

Genus PSEUDONODOSARIA Boomgaart, 1949

Pseudonodosaria larva (Carsey)
Plate 1, figure 8a–b

Nodosaria larva CARSEY, 1926, Texas Univ. Bull. 2612, p. 31, pl. 2, fig. 2.
Nodosaria radicula (Linné). – PLUMMER, 1927, Texas Univ. Bull. 2644, p. 77, pl. 4, fig. 9.
Pseudoglandulina manifesta (Reuss). – CUSHMAN, 1946, U. S. Geol. Survey, Prof. Paper no. 206, p. 76, pl. 27, figs. 21–26.
Pseudonodosaria larva (Carsey). – LOEBLICH AND TAPPAN, 1955, Smithsonian Misc. Coll., vol. 126, no. 3, p. 6, pl. 1, figs. 7–11.

Remarks: The Egyptian specimens are identical with the synonymous forms listed above, showing a rounded base, appressed early chambers, inflated later chambers, and a radiate aperture situated terminally on the turban-shaped final chamber.

Distribution: Best developed in the Danian upper layers of the lower Esna shales; rare in the *Echinocorys* chalk.

Family BULIMINIDAE

Genus BULIMINELLA Cushman, 1911

Buliminella carseyae Plummer
Plate 1, figure 10a–b

Buliminella carseyae PLUMMER, 1931, Texas Univ. Bull. 3101, p. 179, pl. 8, fig. 7.

Remarks: The Egyptian specimens are apparently identical with Plummer's specimens; they show an ovate test with bluntly pointed initial end, four chambers in the last whorl, and a strong depression enclosing a conspicuous comma-shaped aperture, partly surrounded by a narrow flap.

Distribution: Frequent in the Maestrichtian, and extending up to the middle part of the Danian as a rare form.

Genus BULIMINA d'Orbigny, 1826

Bulimina arkadelphiana Cushman and Parker var. **midwayensis** Cushman and Parker
Plate 1, figure 9a–b

Bulimina aculeata d'Orbigny. – PLUMMER, 1927, Texas Univ. Bull. 2644, p. 73, pl. 4, fig. 3.
Bulimina arkadelphiana Cushman and Parker var. *midwayensis* CUSHMAN AND PARKER, 1936, Cushman Lab. Foram. Res., Contr., vol. 12, p. 42, pl. 7, figs. 9–10 (holotype, Cushman Coll., no. 23136).

Remarks: The Egyptian specimens are apparently identical with the holotype; they show five whorls of chambers, of which all but the inflated final one are covered with sharp spines; the well-developed lipped aperture lies at the base of the last-formed chamber.

Distribution: Rare to frequent in the Danian upper layers of the upper Esna shales.

Genus NEOBULIMINA

Cushman and Wickenden, 1928

Neobulimina khargensis Nakkady and Talaat, **new species**
Plate 6, figure 4a–c

Description: Test elongate, about two or three times as long as broad, tapering rapidly toward the slightly twisted initial end, greatest width near the apertural end. Early triserial portion making up about half the length of the test, comprising nine or ten scarcely distinguishable chambers; four to six more distinct chambers make up the mature biserial stage. The last chamber is very loosely attached and is set obliquely over the penultimate one. Sutures indistinct in the early triserial part, more distinct in the biserial part. Wall finely perforate, in most cases covered with minute spines and granules, which may mask the characters of the test. Aperture loop-shaped, extending up from the base of the last-formed chamber.

Remarks: Neobulimina farafrensis LeRoy, from the Maqfi section of the Western Desert of Egypt, has a very similar structure and appears to have been a close relative or descendant of the present species, which must have appeared earlier in geologic history and which differs from *Neobulimina farafrensis* in the usually twisted early portion and in the spinose surface of its test.

Distribution: The species is a very short-lived flood form and stratigraphic marker at the top of the Nubian sandstone. It is rare at the base of the *Exogyra overwegi* beds.

Holotype: Length 0.48 mm.; greatest width 0.19 mm.; selected from sample G.4 and deposited in the U. S. National Museum, Washington, D.C.

Genus BOLIVINA d'Orbigny, 1839

Bolivina daniana Nakkady and Talaat, **new species**
Plate 6, figures 5a–c, 6a–c

Description: Test wedge-shaped, slightly flattened, tapering sharply toward the slightly twisted initial end. Chambers in about five pairs, rapidly increasing in breadth and thickness near the last two pairs, which make up about two-thirds of the length of the test. The last chamber overlaps the penultimate one in such a manner that the test appears to have been crushed, with one chamber gliding over the other. Sutures straight or slightly curved, depressed, with the line of junction between the two series distinctly zigzag. Wall finely perforate; aperture a very small loop-shaped opening, extending up from the base of the last chamber.

Remarks: This new bolivine can scarcely be compared with any known species, its principal distinguishing characters being the apparently crushed form of the test and the overlapping position of the last chamber.

Distribution: Bolivina daniana is a flood form in the top sample of the lower Esna shales and in the basal layers of the *Echinocorys* chalk.

Holotype: Length 0.24 mm.; breadth 0.14 mm.; thickness 0.09 mm.; selected from sample G.11 and deposited in the U. S. National Museum, Washington, D. C.

Genus LOXOSTOMUM Ehrenberg, 1854

Loxostomum applinae (Plummer)
Plate 2, figure 1a–b

Bolivina applinae PLUMMER, 1927, Texas Univ. Bull. 2644, p. 69, pl. 4, fig. 1
Loxostomum applinae (Plummer). – LEROY, 1953, Geol. Soc. Amer., Mem. 54, p. 37, pl. 8, fig. 1 (Cushman Coll., no. 58025).

Remarks: The Egyptian specimens clearly show the slightly twisted initial biserial stage which makes up about one-third of the length of the test. This part shows faint longitudinal striae. Sutures distinctly crenulated and depressed in the uniserial stage. Aperture a terminal oval opening with a small lip.

Distribution: Upper half of the Danian, upper Esna shales.

Family ROTALIIDAE

Genus EPONIDES Montfort, 1808

Eponides lotus (Schwager)
Plate 2, figure 3a–c

Pulvinulina lotus SCHWAGER, 1883, Palaeontographica, vol. 30 (ser. 3, vol. 6), pt. 1, p. 132, pl. 28(5), fig. 9.
Eponides lotus (Schwager). – CUSHMAN, 1932, Cushman Lab. Foram. Res., Contr., vol. 8, pt. 3, p. 71, pl. 9, fig. 8. – LEROY, 1953, Geol. Soc. Amer., 54, p. 30, pl. 11, figs. 4, 8–9.

Remarks: The specimens that can be referred to this species in the Um Elghanayem section or in other sections examined by the writer show a wide range of gradation between the typical *Eponides lotus*, described by Schwager from the Libyan stage of Egypt, and the typical *Eponides candidula*, also described by the same author but from the Middle Eocene Mokattam stage, the minor differences between the two extremes being the greater degree of convexity of the dorsal side in *Eponides lotus* and the sharper keel and higher sutures of *Eponides candidula*. LeRoy's specimens from the Maqfi section seem to incline more toward the type of *Eponides candidula*.

Distribution: In the present section *Eponides lotus* is recorded as a rare form in the *Echinocorys* chalk, becoming more frequent in the higher beds of the upper Esna shales and in the *Nummulites deserti* zone.

Genus ROTALIA Lamarck, 1804

Rotalia rigida (Schwager)
Plate 2, figure 4a–c

Discorbina rigida SCHWAGER, 1883, Palaeontographica, vol. 30 (ser. 3, vol. 6), p. 124, pl. 28(5), fig. 4.

Description: Test distinctly perforate, more or less biconvex, with ten chambers in the last whorl and a distinct umbo on the ventral side. Sutures on the ventral side slightly depressed to limbate and flush with the surface, on the dorsal side oblique and slightly curved. Aperture at the base of the last chamber, on the ventral side near the periphery.

Distribution: Rotalia rigida is a flood form in the upper beds of the lower Esna shales, becoming less abundant in the *Echinocorys* chalk, the overlying upper Esna shales, and the *Nummulites* limestone.

Genus GYROIDINA d'Orbigny, 1826

Gyroidina aegyptiaca Nakkady and Talaat, **new species**
Plate 6, figure 7a–c; plate 7, figure 1a–c

Description: Test trochoid, planoconvex; ventral side strongly convex, showing nine distinct chambers in the last-formed whorl and a deep, open umbilicus. Dorsal side flat, showing about fifteen chambers in two and one-half whorls. Ventral sutures slightly raised, curved, and strongly limbate, becoming much thicker toward the umbilicus. Dorsal sutures also slightly raised, limbate, and faintly curved. Wall smooth, finely perforate; aperture an elongate slitlike opening, extending from the umbilicus to the dorsal edge along the base of the broad apertural face.

Remarks: The present species is very similar to *Gyroidina girardana* (Reuss) in its general form, but differs mainly in the character of the sutures, which are markedly limbate and raised in all the specimens examined.

Distribution: Gyroidina aegyptiaca floods the top layers of the lower Esna shales, where it is best developed, but it is also known as a rare form in the underlying Maestrichtian formations.

Holotype: Length 0.29 mm.; breadth 0.24 mm.; thickness 0.19 mm.; selected from sample G.10D and deposited in the U. S. National Museum, Washington, D. C.

Gyroidina girardana (Reuss)
Plate 3, figure 1a–c

Rotalina girardana REUSS, 1851, Deutsch. Geol. Ges., Zeitschr., vol. 3, p. 73, pl. 5, fig. 34.
Gyroidina girardana (Reuss). – CUSHMAN, 1927, Jour. Pal., vol. 1, p. 164, pl. 25, figs. 7–9. – LEROY, 1953, Geol. Soc. Amer., Mem. 54, p. 35, pl. 5, figs. 10–12. – SAID AND KENAWY, 1956, Micropaleontology, vol. 2, no. 2, p. 148, pl. 5, fig. 7a–c.

Remarks: Specimens belonging to this species clearly show the following diagnostic characters: A wide, open umbilicus; slightly depressed, nearly radial sutures on both sides; a subconical ventral side; a flattened, slightly concave dorsal side; eight to ten chambers in the last whorl; and an elongate aperture that extends between the dorsal edge and the umbilicus.

Distribution: Gyroidina girardana is rather short-lived in the Um Elghanayem section, being limited to the upper layers of the *Echinocorys* chalk and the basal layers of the upper Esna shales, where it is a frequent to abundant form.

Genus VALVULINERIA Cushman, 1926

Valvulineria brotzeni Nakkady and Talaat, **new species**
Plate 7, figure 2a–c

Gyroidina planulata Cushman and Renz. – LEROY, 1953, Geol. Soc. Amer., Mem. 54, p. 35, pl. 11, figs. 1–3, – SAID AND KENAWY, 1956, Micropaleontology, vol. 2, no. 2, p. 149, pl. 5, fig. 8.

Description: Test biconvex, composed of three whorls; dorsal side with a low spire, slightly more convex than the ventral. Chambers distinct, nine or ten in the last whorl, of uniform shape and increasing gradually in size as added. Last chamber extending more toward the umbilicus than the other. Sutures very slightly depressed or flush with the surface. Aperture a slit, extending from the umbilicus to near the dorsal edge beneath a very thin lip, which projects from the base of the subtriangular apertural face. Wall smooth, finely perforate.

Remarks: Valvulineria brotzeni is very similar to *Valvulineria laevis* Brotzen, but can be distinguished by the more convex dorsal side, the triangular apertural face, and the character of the last chamber and the umbilicus.

Distribution: The species is a flood form in the top layers of the lower Esna shales, declining rapidly upward and vanishing in the later beds.

Holotype: Length 0.31 mm.; breadth 0.26 mm.; thickness 0.12 mm.; selected from sample G.10D and deposited in the U. S. National Museum, Washington, D. C.

Valvulineria scrobiculata (Schwager)
Plate 2, figure 5a–b

Anomalina scrobiculata SCHWAGER, 1883, Palaeontographica, vol. 30 (ser. 3, vol. 6), pt. 1, p. 129, pl. 29(6), fig. 18.
Valvulineria scrobiculata (Schwager). – LEROY, 1953, Geol. Soc. Amer., Mem. 54, p. 54, pl. 9, figs. 18–20.
Not *Valvulineria scrobiculata* (Schwager). – SAID AND KENAWY, 1956, Micropaleontology, vol. 2, no. 2, p. 147, pl. 4, fig. 42a–c.

Remarks: The species is easily recognized by its stellate umbilical region, which is produced by the unusually wide and deep umbilicus receiving the deep ventral sutures and surrounded by nodes of clear shell material.

Distribution: At Um Elghanayem, *Valvulineria scrobiculata* is a rather frequent form in the upper Esna shales and the overlying *Nummulites* limestone.

Family CASSIDULINIDAE

Genus ALABAMINA Toulmin, 1941

Alabamina midwayensis Brotzen
Plate 2, figure 2a–c

Pulvinulina exigua (Burrows and Holland). – PLUMMER, 1927, Texas Univ. Bull. 2644, p. 150, pl. 11, fig. 3a–b.
Pulvinulina exigua (Burrows and Holland) var. *obtusa* (Burrows and Holland). – PLUMMER, 1927, Texas Univ. Bull. 2644, p. 151, pl. 11, fig. 2a–c.
Alabamina midwayensis BROTZEN, 1948, Sver. Geol. Unders., ser. C, no. 493, p. 99, pl. 16, fig. 12; text-fig. 26a–b.
Alabamina wilcoxensis Toulmin. – SAID AND KENAWY, 1956, Micropaleontology, vol. 2, no. 2, p. 152, pl. 6, fig. 18.

Remarks: Specimens belonging to this species in the Um Elghanayem section clearly show the typical characters such as subacute periphery and the biconvex test with six or seven chambers in the last whorl. Umbilicus filled with shell material in some specimens. Dorsal side showing about two whorls and a raised central umbo. Sutureon the ventral side straight or very faintly curveds slightly raised, and slightly expanded near the umbilicus, Sutures on the dorsal side strongly oblique, flush with the surface or slightly raised. Wall smooth, markedly perforate; aperture a conspicuous ventral opening at the base of the last chamber.

Distribution: The occurrence of *Alabamina midwayensis* in the Um Elghanayem section is very limited; it is abundant in the top bed of the Danian lower Esna shales, but declines in frequency after that rather rapidly, and vanishes completely at the top of the *Echinocorys* chalk.

Family GLOBIGERINIDAE

Genus GLOBIGERINA d'Orbigny, 1826

Globigerina esnaensis LeRoy
Plate 3, figure 2a–c

Globigerina esnaensis LEROY, 1953, Geol. Soc. Amer., Mem. 54, p. 31, pl. 6, figs. 8–10.
Truncorotalia esnaensis (LeRoy). – SAID AND KENAWY, 1956, Micropaleontology, vol. 2, no. 2, p. 151, pl. 6, fig. 7.

Remarks: Numerous specimens that conform well to LeRoy's description and figures have been found in Um Elghanayem and other sections examined by the writer. The nodes roughening the wall shown by LeRoy's type do not seem, however, to be a persistent character.

Distribution: The Um Elghanayem section indicates extension of the known vertical range of this species, which appears first in the Nubian sandstone as a rare form and becomes conspicuously abundant only in the upper layers of the Danian.

Globigerina mckannai White

Globigerina mckannai WHITE, 1928, Jour. Pal., vol. 2, p. 194, pl. 27, fig. 16a–c.
Globigerina cretacea d'Orbigny var. *esnehensis* NAKKADY, 1950, Jour. Pal., vol. 24, no. 6, p. 689, pl. 90, figs. 14–16.
Rugoglobigerina esnehensis (Nakkady). – SAID AND KENAWY, 1956, Micropaleontology, vol. 2, no. 2, p. 157, pl. 7, fig. 29.

Remarks: Direct comparison of topotypes of White's species in the U. S. National Museum with Egyptian material from Um Elghanayem and other sections that had previously been identified as *Globigerina cretacea* var. *esnehensis* reveals that they are identical. Said and Kenawy's form is not a *Rugoglobigerina*, but is a typical specimen of *Globigerina mckannai*.

Distribution: Globigerina mckannai is a rather abundant form in the upper layers of the *Globorotalia* zone in the upper Esna shales.

Globigerina pseudobulloides Plummer
Plate 3, figure 4a–c

Globigerina pseudobulloides PLUMMER, 1927, Texas Univ. Bull. 2644, p. 133, pl. 8, fig. 9.

Remarks: Specimens from Um Elghanayem and other Egyptian sections were compared directly with Plummer's types, and proved to be identical. Many of the Egyptian forms previously identified as *Globigerina cretacea* d'Orbigny or *Globigerina bulloides* d'Orbigny should probably be placed in the present species. The single arched umbilical aperture, and the low-spired five-chambered test with two and one-half whorls are the principal diagnostic features of the species.

Distribution: Globigerina pseudobulloides is known in the present section from the *Cardita* horizon to the basal layers of the *Nummulites deserti* zone, but its best development is in the top layer of the lower Esna shales and the basal beds of the *Echinocorys* chalk. Its absence from LeRoy's Maqfi section and from Said and Kenawy's sections should be reviewed in the light of the present findings.

Globigerina quadrata White
Plate 3, figure 3a–c

Globigerina bulloides d'Orbigny. – SCHWAGER, 1883, Palaeontographica, vol. 30 (ser. 3, vol. 6), p. 118, pl. 27(4), fig. 5.
Globigerina quadrata WHITE, 1928, Jour. Pal., vol. 2, p. 195, pl. 27, fig. 18.

Distribution: Globigerina quadrata is a rare form in the Maestrichtian Nubian sandstone and *Exogyra overwegi* beds, but floods the Danian upper layers of the lower Esna shales, the *Echinocorys* chalk, and the upper Esna shales. The species declines in importance subsequently, toward and in the *Nummulites deserti* zone.

Globigerina triloculinoides Plummer
Plate 3, figure 5a–c

Globigerina triloculinoides PLUMMER, 1927, Texas Univ. Bull. 2644, p. 134, pl. 8, fig. 10. – BROTZEN, 1948, Sver. Geol. Unders., ser. C, no. 493, p. 89, pl. 17, fig. 2.
Globigerina linaperta FINLAY, 1939, Roy. Soc. New Zealand, Trans. Proc., vol. 69, pt. 1, p. 129, pl. 13, figs. 54–57. – SAID AND KENAWY, 1956, Micropaleontology, vol. 2, no. 2, p. 157, pl. 7, fig. 27.
Globigerina pseudotriloba White. – LEROY, 1953, Geol. Soc. Amer., Mem. 54, p. 31, pl. 9, fig. 27. – SAID AND KENAWY, 1956, Micropaleontology, vol. 2, no. 2, p. 157, pl. 7, fig. 25.

Remarks: There is a very wide range of variation and gradation within the vast population that may belong to this species. A detailed study of the relationships of the forms that occur in the Paleocene, which can safely be assigned to *Globigerina triloculinoides*, to the very similar forms that occur below them in the Upper Cretaceous is needed in order to distinguish their apparently overlapping characters.

Distribution: In the present section, *Globigerina triloculinoides* appears first in the upper Maestrichtian as a frequent form (five to nine specimens in 0.5 g. of sample), and gradually increases in importance toward the *Echinocorys* chalk and into the upper Esna shales, where it floods the fauna. It then declines rapidly in the *Nummulites deserti* zone.

Family GLOBOROTALIIDAE

Genus GLOBOROTALIA Cushman, 1927

Globorotalia angulata (White)
Plate 4, figure 1a–c

Globigerina angulata WHITE, 1928, Jour. Pal., vol. 2, p. 191, pl. 27, fig. 13.
Globorotalia colligera (Schwager). – NAKKADY, 1951, Alexandria, Univ., Bull. Fac. Sci., no. 1, p. 50, pl. 1, fig. 1.
Not *Truncorotalia colligera* (Schwager). – SAID AND KENAWY, 1956, Micropaleontology, vol. 2, no. 2, p. 151, pl. 6, fig. 5.

Globorotalia simulatilis (Schwager). – LEROY, 1953, Geol. Soc. Amer., Mem. 54, p. 32, pl. 9, figs. 1–2.

Remarks: The diagnostic characters of this species, which is very well represented in the Egyptian Lower Paleocene sections, are the planoconvex form, the sharply angular to subacute, occasionally keeled, spinose periphery, the four to four and one-half chambers in the last whorl, the depressed, nearly radial sutures on the ventral side, and the curved and less depressed sutures on the dorsal side. The umbilicus is deep and open, and the aperture extends along the periphery, at the base of the chamber. The species can easily be distinguished from the closely similar *Globorotalia simulatilis* by its lower spire, smaller number of chambers, and less curved dorsal sutures.

Distribution: In the present section the species is a flood form throughout the *Globorotalia* zone (the *Echinocorys* chalk and the upper Esna shales), after which it declines very rapidly in the *Nummulites deserti* zone.

Globorotalia crassata (Cushman) var. **aequa** Cushman and Renz

Globorotalia crassata (Cushman) var. *aequa* CUSHMAN AND RENZ, 1942, Cushman Lab. Foram. Res., Contr., vol. 18, p. 12, pl. 3, fig. 3.

Not *Truncorotalia crassata aequa* (Cushman and Renz). – SAID AND KENAWY, 1956, Micropaleontology, vol. 2, no. 2, pl. 6, fig. 8.

Remarks: This variety, which has been reported from all Paleocene localities studied in Egypt, is easily recognized by its planoconvex test with an acute, usually keeled, spinose periphery and three and one-half chambers in the last whorl, the last one of which occupies about half the size of the test. The aperture is an arched slit extending between the umbilicus and the peripheral edge.

Distribution: The species floods the Danian fauna of the present section, but, like the other sharply keeled Globorotalias, becomes inconspicuous in the *Nummulites* limestone.

Globorotalia quadrata Nakkady and Talaat, **new species**
Plate 7, figure 3a–c

Description: Test quadrate, trochoid, composed of about two whorls, the dorsal side flattened or slightly convex, the ventral side distinctly convex. Peripheral edges subacute and very finely spinose. Chambers few in number, four in the last whorl, petaloid on the dorsal side, the last one usually smaller than the penultimate. Umbilicus deep and open. Sutures on ventral side nearly straight and strongly depressed. Sutures on the dorsal side curved, indistinct, and flush with the surface. Wall distinctly perforate and very finely spinose. Aperture a narrow slit extending from the umbilicus to near the periphery.

Remarks: The characters of this species make it unique among the globorotaliids. Its quadrate form appears to link it with *Globigerina quadrata* White, which floods the same samples in which the present species occurs, but which appears earlier in the section and could thus have been its ancestor.

Distribution: Abundant in the lower layers of the *Globorotalia* zone, becoming less frequent above, and not observed in the top layers of the upper Esna shales or in the *Nummulites* limestone.

Holotype: Length 0.29 mm.; breadth 0.29 mm.; thickness 0.17 mm.; selected from sample G.12 and deposited in the U. S. National Museum, Washington, D. C.

Globorotalia simulatilis (Schwager)
Plate 4, figure 2a–c

Discorbina simulatilis SCHWAGER, 1883, Palaeontographica, vol. 30 (ser. 3, vol. 6), pt. 1, p. 120, pl. 29(6), fig. 15.

Remarks: The important distinguishing characters of this species are the high spire, the planoconvex, acute-edged, keeled test, and the characteristic dorsal side showing strongly curved, very slightly raised sutures and petaloid chambers.

Distribution: In the present section *Globorotalia simulatilis* floods the fauna of the *Echinocorys* chalk and the upper Esna shales. It is a frequent form in the *Nummulites deserti* zone.

Globorotalia velascoensis (Cushman)
Plate 4, figure 4a–c

Pulvinulina velascoensis CUSHMAN, 1925, Cushman Lab. Foram. Res., Contr., vol. 1, no. 6, p. 19, pl. 3, fig. 5.

Globorotalia velascoensis (Cushman). – LEROY, 1953, Geol. Soc. Amer., Mem. 54, p. 33, pl. 3, figs. 1–3.

Remarks: In the very rich *Globorotalia* population of the Egyptian Danian, many forms show characters intermediate between those of the two closely related species *Globorotalia simulatilis* and *G. velascoensis*. The typical forms of *G. velascoensis* can be distinguished mainly by the more rounded, acutely carinate test, in which the chambers on the ventral side are prolonged around the wide depressed umbilicus, and by the less strongly curved dorsal sutures.

Distribution: Flooding the *Globorotalia* zone (the *Echinocorys* chalk and upper Esna shales).

Globorotalia pseudomenardii Bolli
Plate 4, figure 3a–c

Globorotalia membranacea (Ehrenberg). – LEROY, 1953, Geol. Soc. Amer., Mem. 54, p. 32, pl. 3, figs. 13–14.

Globorotalia pseudomenardii BOLLI, 1957, U. S. Nat. Mus., Bull. 215, p. 77, pl. 20, figs. 14–17.

Remarks: This typical *Globorotalia* of the *tumida* type is characterized by a rather compressed biconvex test, with about five slightly inflated lobulate chambers, depressed sutures, and a typical *tumida* aperture.

Distribution: Abundant in the *Echinocorys* chalk, becoming much less conspicuous in the overlying upper Esna shales, and dying out completely below the *Nummulites* limestone.

Family ANOMALINIDAE

Genus ANOMALINA d'Orbigny, 1826

Anomalina umbonifera (Schwager)

Discorbina praecursoria Schwager var. *umbonifera* SCHWAGER, 1883, Palaeontographica, vol. 30 (ser. 3, vol. 6), pt. 1, p. 126, pl. 27(4), fig. 14a–c.
Cibicides libycus LEROY, 1953, Geol. Soc. Amer., Mem. 54, p. 24, pl. 5, figs. 1–3.
Anomalina grandis LeRoy. – SAID AND KENAWY, 1956, Micropaleontology, vol. 2, no. 2, p. 153, pl. 6, fig. 16a–c.

Remarks: The diagnostic characters of this large, easily recognizable species are the large biconvex test, composed of two and one-half whorls, the last one containing about nine distinctly perforate chambers. The central parts of both the ventral and the dorsal sides are covered by clear shell material. Aperture median, at the base of the last chamber.

Distribution: Anomalina umbonifera is a rather frequent form in the *Globorotalia* zone of the present section, and also survived the shoaling of the seas in the succeeding Montian.

Genus CIBICIDES Montfort, 1808

Cibicides multifarius (Schwager)

Discorbina multifaria SCHWAGER, 1883, Palaeontolographica, vol. 30 (ser. 3, vol. 6), pt. 1, p. 121, pl. 27(4), fig. 10; pl. 29(6), fig. 17.

Remarks: Specimens belonging to this species from Um Elghanayem and other sections in Egypt show a wide range of variation in a number of characters; the outline of the test ranges from perfectly rounded and biconvex to slightly longer than wide; the sutures may be thin or limbate. The saddle-shaped form of the sutures is very characteristic.

Distribution: Rather frequent to abundant in the middle Danian. The species survived the upper Lower Paleocene *Nummulites* limestone.

Genus ANOMALINOIDES Brotzen

Anomalinoides danicus (Brotzen)
Plate 5, figure 2a–c

Cibicides danica BROTZEN, 1940, Sver. Geol. Unders., ser. C, no. 435, p. 31; p. 25, text-fig. 2a–c.
Anomalinoides danica (Brotzen). – BROTZEN, 1948, Sver. Geol. Unders., ser. C, no. 493, p. 87, pl. 14, fig. 1; text-fig. 22.
Anomalina granosa (Hantken). – LEROY, 1953, Geol. Soc. Amer., Mem. 54, p. 17, pl. 6, figs. 1–3. – SAID AND KENAWY, 1956, Micropaleontology, vol. 2, no. 2, p. 153, pl. 6, fig. 20.

Remarks: The distinguishing characters of this species are the coarsely perforate calcareous test with a rounded periphery, a triangular to ovoid apertural face, about eight inflated chambers, and a peripheral aperture situated nearer the ventral edge and extending somewhat onto the umbilical side beneath a narrow lip.

Distribution: The species occurs in and floods the top layers of the lower Esna shales, where it is considered to be a stratigraphic marker.

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EXPLANATION OF PLATES

PLATE 1

1 *Spiroplectammina carinata* (d'Orbigny)
a–b, side and apertural views, × 148.

2 *Spiroplectoides clotho* (Grzybowski)
a–b, side and apertural views, × 148.

3 *Verneuilina cretacea* Karrer
a–b, side and apertural views, × 148.

4 *Gaudryina austinana* Cushman
a–b, side and apertural views, × 65.

5 *Gaudryina laevigata* White
a–b, side and apertural views, × 65.

6 *Gaudryina pyramidata* Cushman
a–b, side and apertural views, × 65.

7 *Robulus midwayensis* (Plummer)
a–b, side and peripheral views, × 93.

8 *Pseudonodosaria larva* (Carsey)
a–b, side and apertural views, × 70.

9 *Bulimina arkadelphiana* Cushman and Parker
var. *midwayensis* Cushman and Parker
a–b, side and apretural views, × 148.

10 *Buliminella carseyae* Plummer
a–b, side and apertural views, × 65.

PLATE 2

1 *Loxostomum applinae* (Plummer)
a–b, side and apertural views, × 93.

2 *Alabamina midwayensis* Brotzen
a–c, dorsal, ventral, and peripheral views, × 148.

3 *Eponides lotus* (Schwager)
a–c, dorsal, ventral, and peripheral views, × 148.

4 *Rotalia rigida* (Schwager)
a–c, dorsal, ventral, and peripheral views, × 214.

5 *Valvulineria scrobiculata* (Schwager)
a–b, dorsal and peripheral views, × 148.

PLATE 3

1 *Gyroidina girardana* (Reuss)
a–c, dorsal, ventral, and lateral views, × 214.

2 *Globigerina esnaensis* LeRoy
a–c, dorsal, lateral, and ventral views, × 148.

3 *Globigerina quadrata* White
a–c, dorsal, ventral, and lateral views, × 148.

4 *Globigerina pseudobulloides* Plummer
a–c, dorsal, ventral, and lateral views, × 148.

5 *Globigerina triloculinoides* Plummer
a–c, dorsal, ventral, and lateral views, × 148.

PLATE 4

1 *Globorotalia angulata* (White)
a–c, dorsal, ventral, and peripheral views, × 148.

2 *Globorotalia simulatilis* (Schwager)
a–c, dorsal, ventral, and peripheral views, × 214.

3 *Globorotalia pseudomenardii* Bolli
a–c, dorsal, ventral, and peripheral views, × 214.

4 *Globorotalia velascoensis* (Cushman)
a–c, dorsal, ventral, and peripheral views, × 93.

PLATE 5

1 *Anomalina luxorensis* Nakkady
a–c, dorsal, ventral, and lateral views, × 214.

2 *Anomalinoides danicus* (Brotzen)
a–c, dorsal, ventral, and lateral views, × 122.

3 *Nummulites deserti* de la Harpe
a–b, side and peripheral views, × 65.

PLATE 6

1 *Ammobaculites khargensis* Nakkady and Talaat, n. sp.
Holotype; a–b, side and peripheral views, × 65.

2 *Ammobaculites khargensis* Nakkady and Talaat, n. sp.
Paratype; a–b, side and peripheral views, × 65.

3 *Gaudryina textulariformis* Nakkady and Talaat, n. sp.
Holotype and topotype; a–d, side and apertural views, × 148.

4 *Neobulimina khargensis* Nakkady and Talaat, n. sp.
Holotype and paratype; a–c, side and apertural views, × 148.

5 *Bolivina daniana* Nakkady and Talaat, n. sp.
Holotype; a–c, side and apertural views.

6 *Bolivina daniana* Nakkady and Talaat, n. sp.
Paratype; a–b, side and apertural views, × 214.

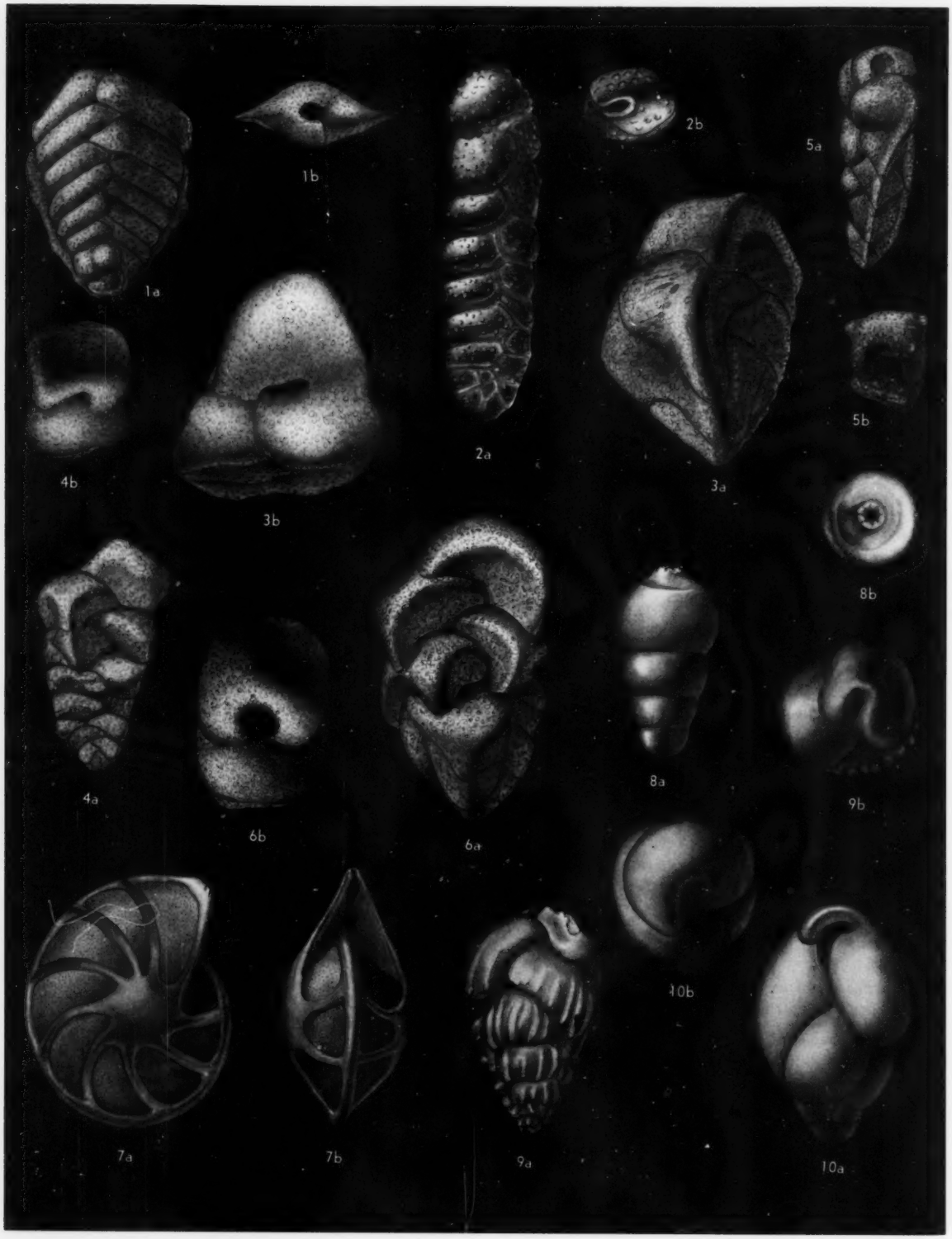
7 *Gyroidina aegyptiaca* Nakkady and Talaat, n. sp.
Holotype; a–c, dorsal, ventral, and lateral views, × 214.

PLATE 7

1 *Gyroidina aegyptiaca* Nakkady and Talaat, n. sp.
Paratype; a–c, dorsal, ventral, and lateral views, × 214.

2 *Valvulineria brotzeni* Nakkady and Talaat, n. sp.
Holotype, a–c, dorsal, ventral, and lateral views, × 148.

3 *Globorotalia quadrata* Nakkady and Talaat, n. sp.
Holotype; a–c, dorsal, ventral, and lateral views, × 148.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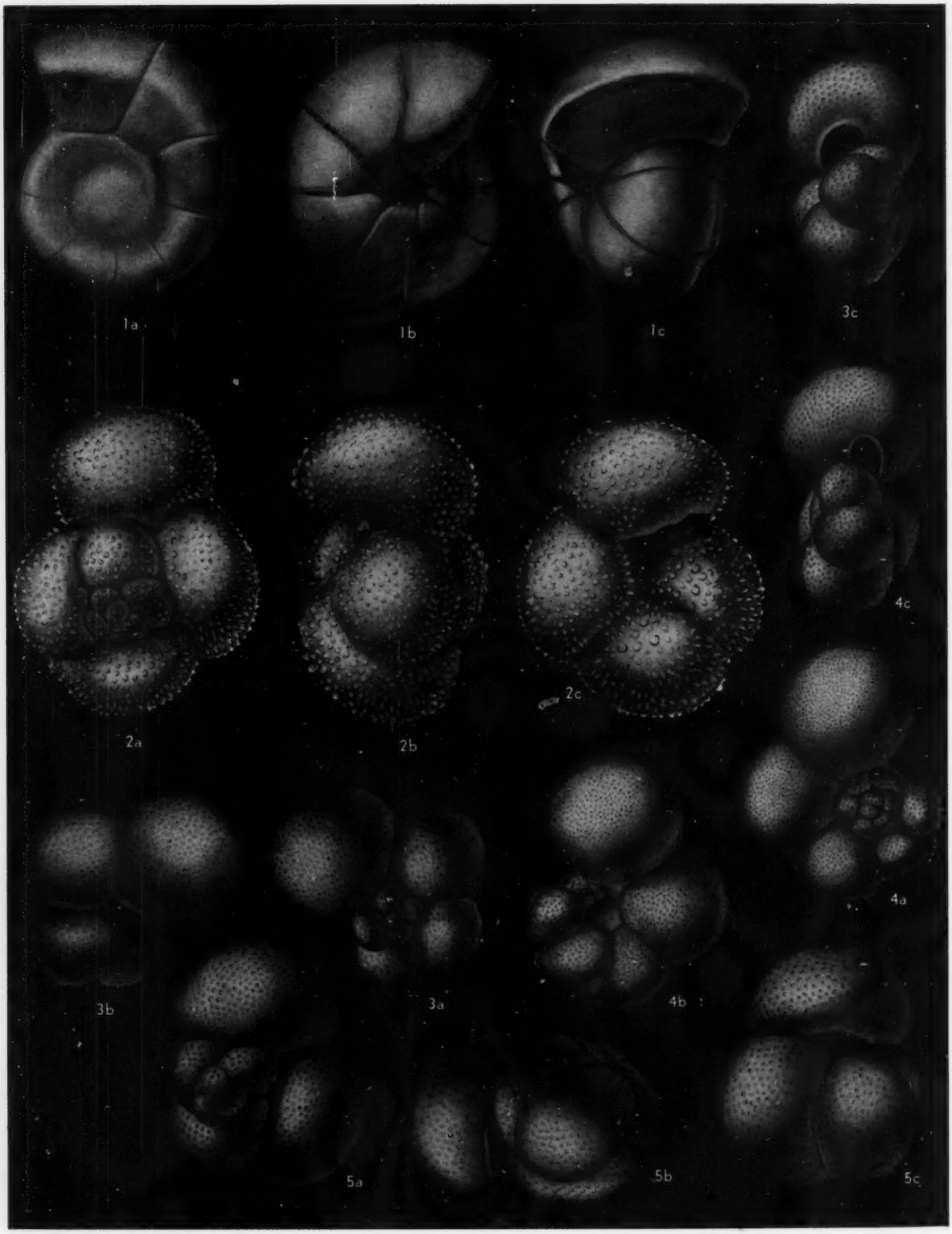
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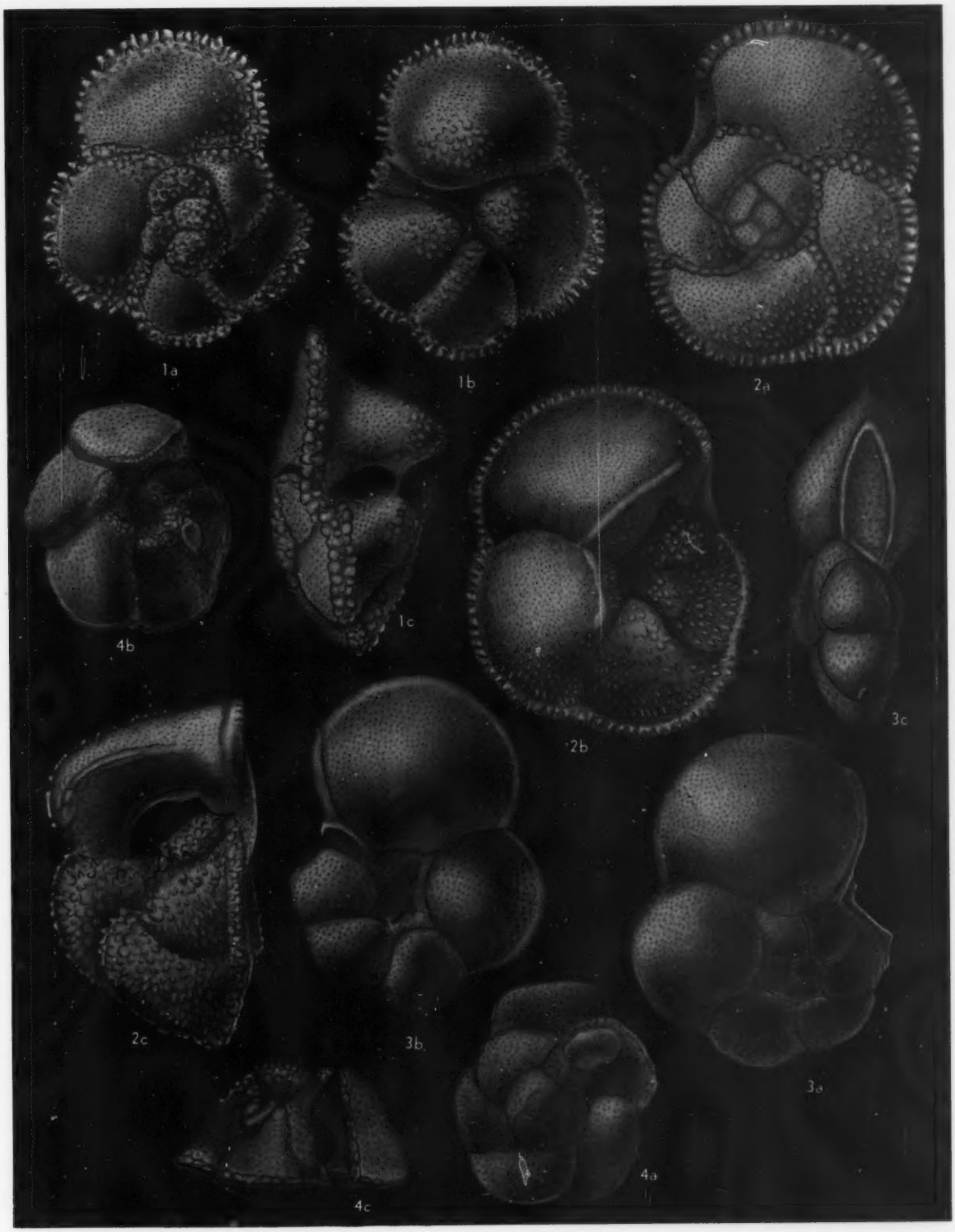
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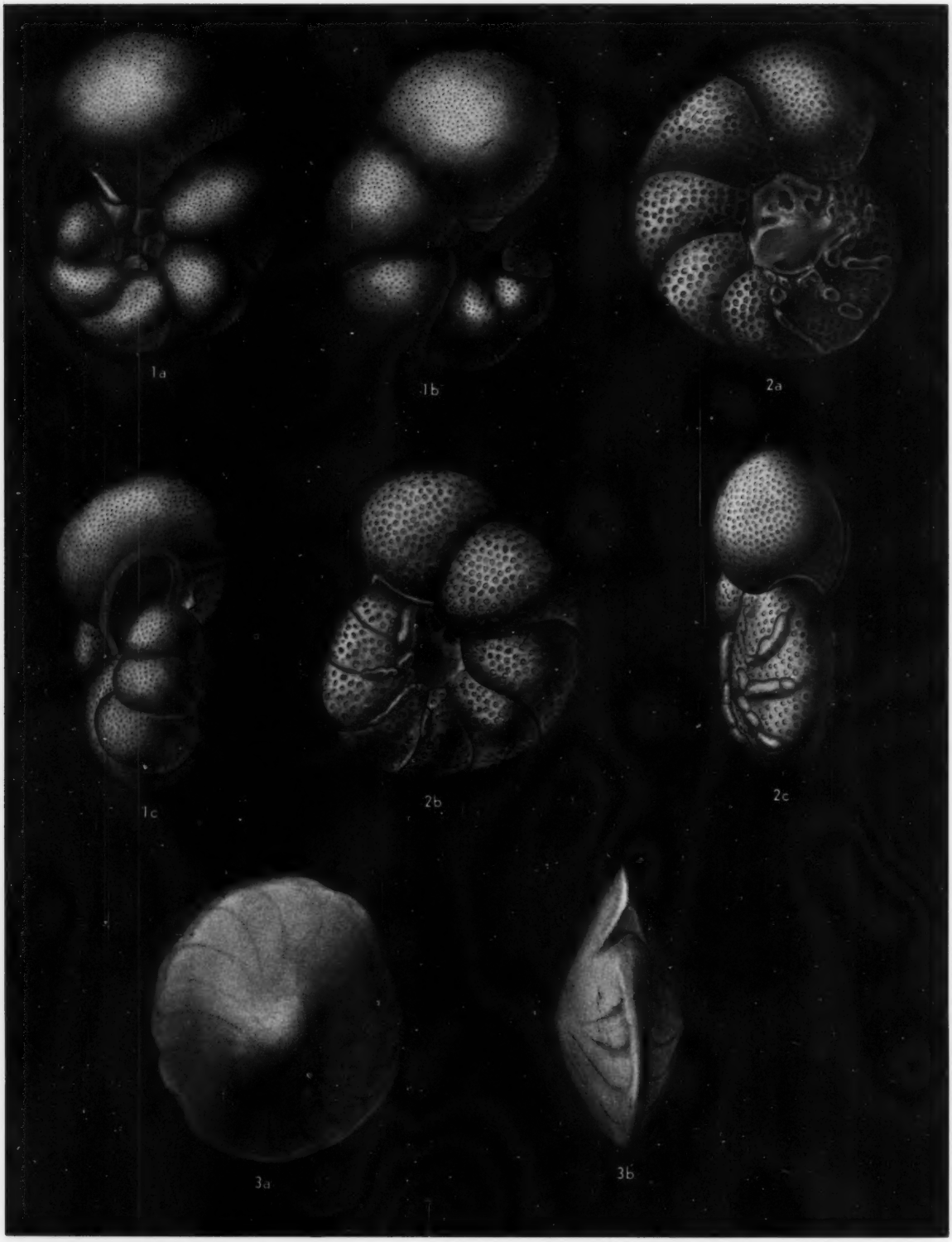
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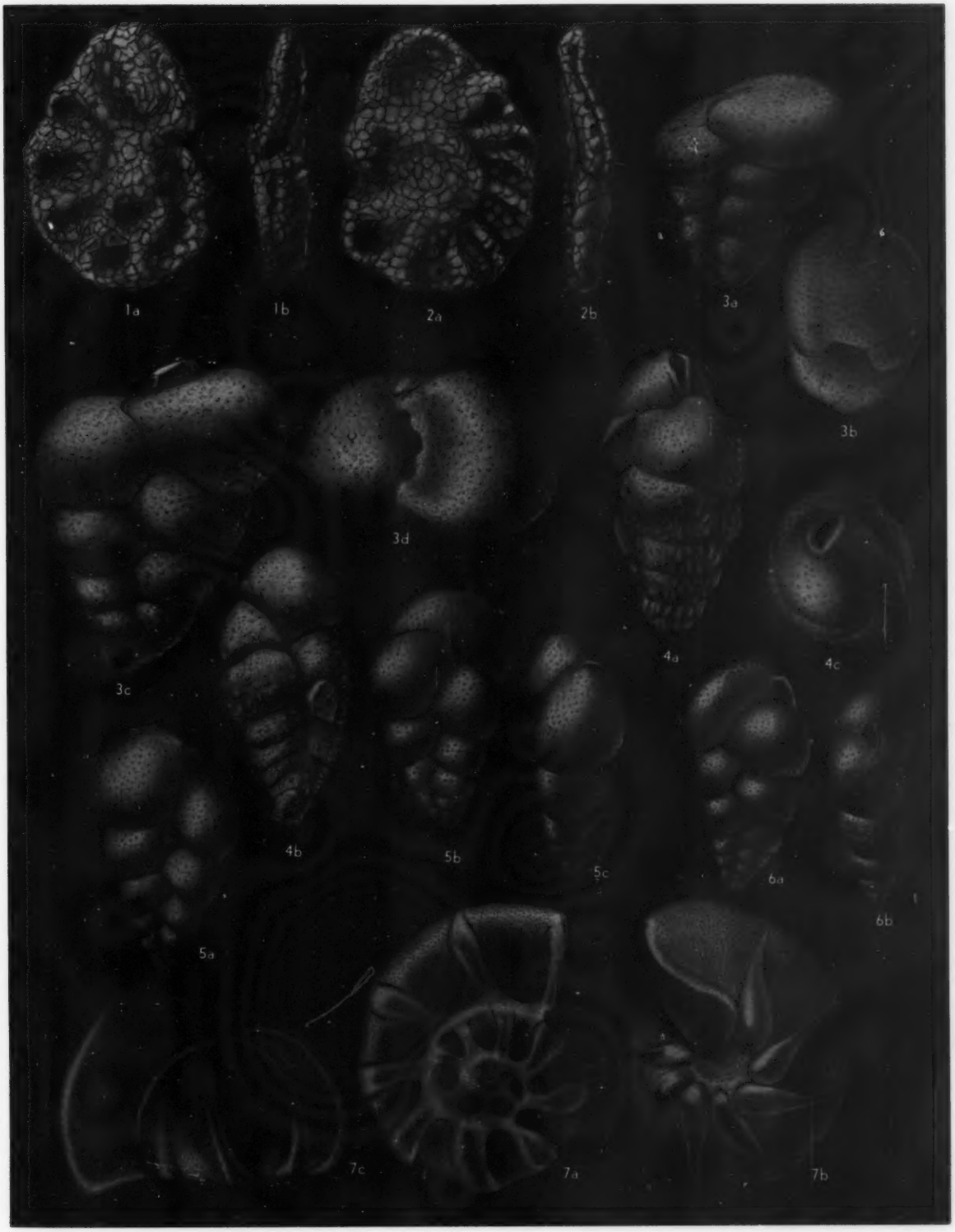
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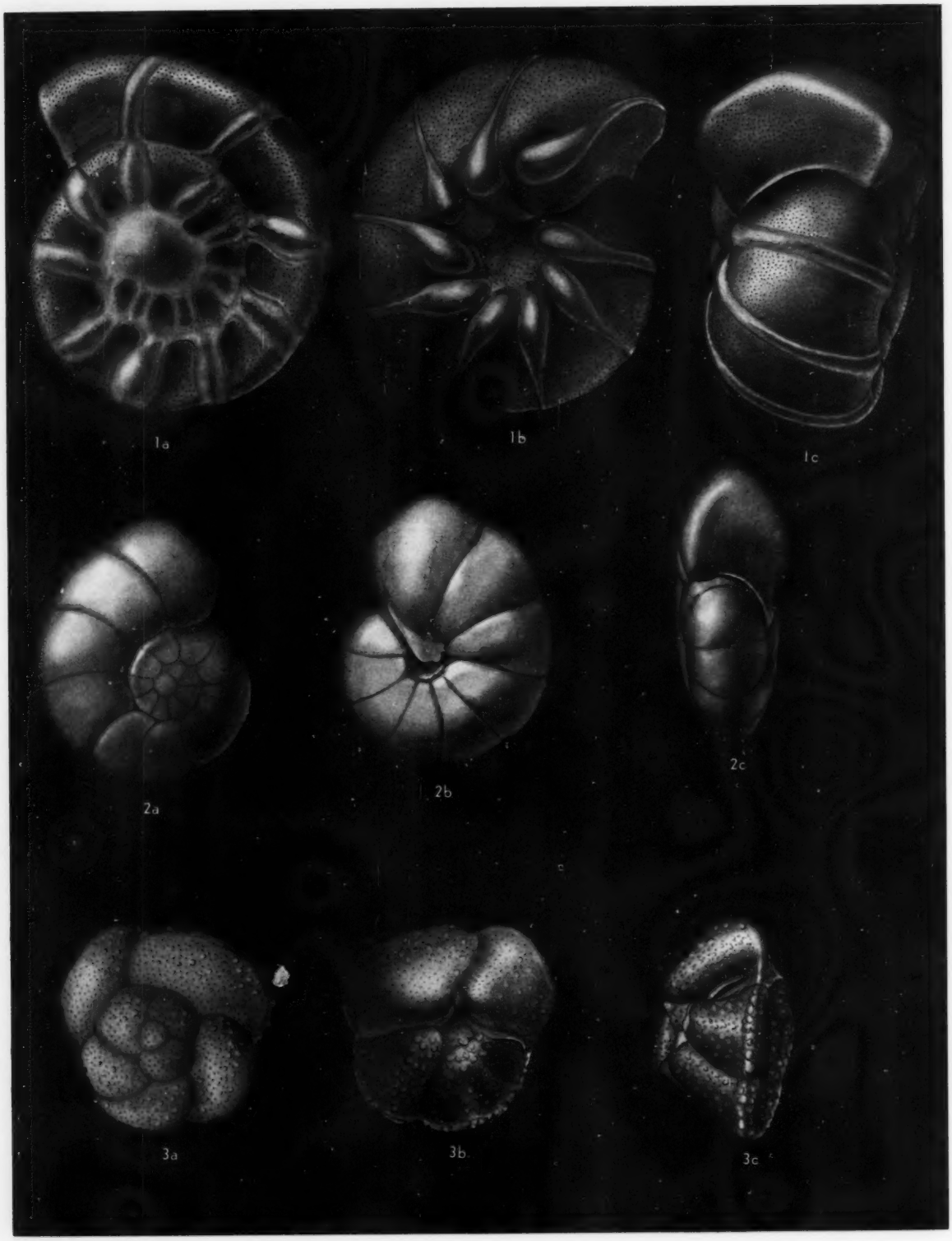
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ABSTRACT: *In the present study foraminifera are used for the first time to determine the limits of ocean currents. Argentine ocean waters are divided into three masses; the planktonic and benthonic foraminifera that are biological indicators of these masses have been determined, and on this basis the western limit of the Malvin current waters on the northern part of the Argentine shelf has been defined. It is believed that the Malvin waters extend up to latitude 22° S., near Cabo Frio, but do not reach the shores of Brazil, and that they sink, become mixed with waters of other origins, and are distributed only on the sea bottom, being covered by the Brazilian waters.*

Foraminifera as biological indicators in the study of ocean currents

ESTEBAN BOLTOVSKOY
Departamento de Oceanografía
Servicio de Hidrografía Naval
Buenos Aires, Argentina

The usual method of determining the boundaries of ocean currents is to measure the hydrographic properties (temperature, salinity, etc.) of the water in the area studied. This method, however, is not the only possible one. The marine population depends on the water mass, and all water masses have their own assemblages of characteristic animals and plants. Becuse of this fact, it is possible to recognize changes of water masses in a sea on the basis of changes in the living organisms.

Furthermore, there are cases when the discrimination of different water masses by means of the living organisms is more efficient than by physico-chemical measurements. For example, it is well known that the waters of the Bering Sea flow into the Arctic Ocean. They have a higher temperature than the latter, but within a relatively short distance their temperature is lowered to such a degree that this character can no longer serve as an indicator. Nevertheless, their planktonic organisms continue to be carried by the Bering Sea waters for a long distance, and thus indicate the true distributation of waters coming from that sea (Lubny-Gerthyk, 1955).

The organisms that are used to separate different water masses are called biological indicators. It is quite understandable that the best biological indicators belong to the plankton, because they have no movement of their own and are closely confined to the waters where they live. The fact that planktonic organisms can indicate different water masses and their movements has previously been discussed, in papes published at the beginning of the present century. For example, it was observed that in the English Channel the percentage of oceanic species increases from west to east. Bygrave (1911) stated that those which occur periodically are "... probably greatly influenced by hydrographic causes, such as the ocean currents and the inflow of Atlantic water into the Channel." He was speaking mainly of diatoms and copepods.

Other students of the same region have observed the same phenomenon of periodic penetration of various representatives of diatoms and copepods, as well as of several different oceanic organisms. Among these writers Russell (1935) should be mentioned especially. He enlarged considerably the number of planktonic species that are useful as biological indicators. His discussions were concerned mainly with *Sagitta* (Chaetognatha). He had plentiful data and was able to draw more detailed conclusions concerning the relationships between the different water masses and their biological indicators in the area in question than the previous investigators.

In several cases the study of planktonic organisms has made it possible to recognize the character of water movements in regions that were very little known hydrographically until the present. For example, Jashnov (1927) stated that one particular alga is a very good indicator of the current which enters the Kara Sea from the west. The variations in its occurrence correspond closely to oscillations in the velocity and direction of this current. Virketis (1929) was able to define the direction of water movement from the Barents to the White Sea and vice versa on the basis of a study of the distribution of planktonic Infusoria and other organisms. Somewhat later the same author (Virketis, 1943) was able to establish the presence and character of cursents existing in Vilkitsky Strait with the help of zooplankton.

The list of publications dealing specifically with planktonic organisms as indicators of ocean currents and containing attemps to define the latter on the basis of a study of the plankton could be further extended. It is rather striking, however, that no foraminiferal indicators have been mentioned. Planktonic foraminifera are known to be sensitive to ecological changes, numerous, and widely distributed throughout the world. It is therefore logical to expect that their distribution would depend on the distribution of different water masses, that among them species could be found that can serve as good biological indicators, and that some attempt should have been made to define ocean currents with their help. Actually, several students (for example, W. Schott, 1935; Ericson, 1953; Phleger, 1954; Shchedrina, 1957; Saidova, 1958; and Bé, 1959) have observed that the distribution of planktonic foraminifera is influenced by ocean currents, but as far as the present author is aware, no attempt has been made to determine the limits of any Recent surface current on this basis.

With respect to benthonic faunas in relation to the problem of biological indicators, there is, in general, very little published material. Still less is known concerning the use of benthonic foraminifera as indicators. In 1929 Mesjathev, using *Astrorhiza arenaria*, *Saccammina sphaerica*, and *Rhabdammina abyssorum* as biological indicators, drew the conclusion that some water from the Barents Sea enters the Kara Sea, being carried by a branch of the North Cape current. Various data on the distribution of benthonic foraminifera as influenced by the distribution of different water masses in the Arctic seas can be found in numerous papers by Shchedrina (1938–1958), as well as by some other students of various seas, but all of these data do not make it possible to plot the exact boundaries of any water masses or currents on a map.

The present paper represents the first attempt of this kind. The author will try to define the source, path, and boundaries of the Recent ocean currents in the Argentine epicontinental sea and adjecent areas on the basis of the distribution of the foraminifera (both planktonic and benthonic) encountered there. The complete report, including all the data and discussion, is too large to be published in this quarterly, and is now being prepared for the press elsewhere. The present paper is an abridgment, and as such may sometimes be rather laconic in style. Nevertheless, the method of work, as well as the main results obtained, we believe are described in sufficient detail to be intelligible.

It is known (Krümmel, 1883; G. Schott, 1944) that the following water masses, from west to east, are observable in the Argentine epicontinental sea: a) The coastal-zone water; b) the cold Malvin (Falkland Islands) current, which has considerable flow from south-southwest to north-northeast; c) the warm waters that flow from north to south, belonging to the rather strong Brazilian current. In addition, an area influenced by the fresh waters carried by the Rio de la Plata can be recognized, but we shall not touch upon it is this paper. On the Argentine shelf, the first two masses occupy the entire depth of water from the surface to the bottom. The Brazilian current waters are situated above the great depths, and between them and the sea floor are waters of other origin.

The main purposes of the present study were as follows: 1) To determine the benthonic and planktonic foraminifera that can serve as biological indicators of the three masses of water listed above; 2) on the basis of these biological indicators to define, where possible, the boundaries of these masses; 3) using the same indicators, to get an idea (although approximate) of the chief area of origin of the Malvin current waters and the farthest northern point which they reach. To carry out these purposes, the following material was studied: a) 148 bottom samples collected from different points on the South American Atlantic shelf between lat. 33° S. and lat. 44° S.; b) one bottom sample taken near the southern limit of the area mentioned but at a depth of 1463 meters; c) 65 bottom samples from the southern Brazilian coastal zone down to a depth of 340 meters, collected between lat 21° 40′ S. and lat. 33° 40′ S.; d) six samples collected from the same area but on the shore or quite near it; e) 23 samples of plankton collected between lat. 40° 30′ S. and lat. 42° S. and between long. 40° W. and long. 57° W., from the surface down to a depth of 200 meters; and f) 34 samples of plankton taken from Brazilian surface waters in the region of the shelf from lat. 22° 40′ S. southward.

In addition, the author has reviewed the material used for his own previous papers on South Atlantic Recent foraminifera, as well as some material belonging to other students of the same area. All of the data in the literature that relates to the present problem were also incorporated. Nevertheless, it is quite understandable that the available material was not sufficient to fulfil all the purposes to the same degree of detail. It will be indicated which of the results obtained should be considered only provisional.

The results of the study are listed below, in an order corresponding to that of the purposes enumerated above.

1) The coastal zone is characterized by an undersized and somewhat depauperate foraminiferal fauna (Boltovskoy, 1956). The most common benthonic species are *Buccello frigida* (Cushman), *Quinqueloculina seminulum* (Linné), *Triloculina subrotunda* (Montagu), *Pyrgo patagonica* (d'Orbigny), *Buliminella elegantissima* (d'Orbigny), and *Rotalia beccarii* (Linné). Some representatives of *Elphidium*, *Bolivina*, and other genera are also present. Almost no planktonic species were observed in this zone.

In the second zone, that of the Malvin current, the foraminiferal fauna is abundant, and many benthonic species are large and well developed. Those listed below can be considered the chief biological indicators of its waters: *Cassidulina crassa* d'Orbigny (forma "*typica*" and forma *media*), *Cassidulinoides parkerianus* (Brady), *Ehrenbergina pupa* (d'Orbigny), *Uvigerina bifurcata* d'Orbigny, *Angulogerina angulosa* (Williamson), (*Pullenia subcarinata subcarinata* (d'Orbigny), *Buccella peruviana campsi* (Boltovskoy), and *Cibicides aknerianus* (d'Orbigny). Planktonic indicators are the following: *Globigerina pachyderma* (Ehrenberg), *Globigerina bulloides* d'Orbigny, *Globigerina inflata* d'Orbigny, *Globigerina conglomerata* Schwager, and *Globorotalia truncatulinoides* (d'Orbigny).

The third zone, the farthest from the shore, belongs to the current from Brazil. Its fauna is of the West Indian type. The benthonic species are not pertinent to our present discussions, because, in the area in question, the Brazilian current waters flow on the surface and to not reach the sea bottom. The planktonic species that can serve as biological indicators in the region discussed are *Globorotalia menardii* (d'Orbigny) (forma "*typica*" and forma *tumida*), *Globigerina eggeri* Rhumbler, *Globigerinoides ruber* (d'Orbigny), *Globigerinoides sacculifer* (Brady), *Globigerinoides conglobatus* (Brady), and others.

The lists of biological indicators of the three zones given above were obtained as a result of the study of the corresponding samples (planktonic and benthonic from the three zones, and, where possible, were substantiated by data from the literature (d'Orbigny, 1839; Brady, 1884; Cushman and Parker, 1931; Heron-Allen and Earland, 1932). All the species listed are easily determinable and in most cases fairly abundant. As the Malvin current was the chief object of our attention, its biological indicators are figured on the accompanying plates (1–3). In addition, the following observations concerning their taxonomy should be given. Because the present study is not of a systematic but rather of an oceanographic nature, however, these observations are very brief.

The most typical Malvinic benthonic species is *Ehrenbergina pupa*. As far as the author knows, it has never been recorded elsewhere, at least in the Southern Hemisphere. Heron-Allen and Earland (1932) stated that the specimen from the Azores cited by Brady (1884) does not represent d'Orbigny's species. *Cassidulina crassa* is polymorphic (Heron-Allen and Earland, 1932), and is encountered in three forms, the most striking difference among which is size, although other differences also exist. The typical form, as described by d'Orbigny (1839), is 1 mm. in diameter (forma "*typica*"), and the second, called here forma *media*, undoubtedly representing the starved condition of the former, measures 0.5 mm.; both are native to the Malvin waters. A very diminutive (0.2 mm.) hyaline form, which is called temporarily forma *minima*, is not peculiar to these waters, as similar specimens thrive in the Argentine coastal zone and elsewhere. It is cosmopolitan and probably does not belong to true *Cassidulina crassa* d'Orbigny. *Pullenia subcarinata subcarinata*, the nominate subspecies, is replaced by *Pullenia subcarinata quinqueloba* in the warm water off Brazil. Large, well developed tests of *Buccella peruviana campsi* and *Cibicides aknerianus* are also typical of the Malvin current. Considerably smaller and somewhat different representatives of this species live in the coastal zone but are easily distinguishable.

Among the planktonic fauna, the most characteristic species is *Globigerina pachyderma*. This species, as understood here, includes forms listed by some authors as *Globigerina dutertrei*. The corresponding specimen with five chambers in the last whorl is figured on the plate 3 of the present paper. *Globigerina inflata*, *Globigerina bulloides*, and *Globigerina conglomerata* live not only in the sub-Antarctic waters but also in those of the Brazilian current, although in much reduced numbers. The latter two species appear to intergrade. Nevertheless, until a special study is made, and in accordance with the view of Heron-Allen and Earland (1932), well known specialists on Antarctic foraminifera, *Globigerina conglomerata* is considered in the present paper as an independent species. *Globoratalia truncatulinoides* has been recorded in lower latitudes, but its representatives in the Malvin waters are easily distinguishable, being smaller and often biconvex. In summary it must be emphasized that the species enumerated above have distinct significance as biological indicators.

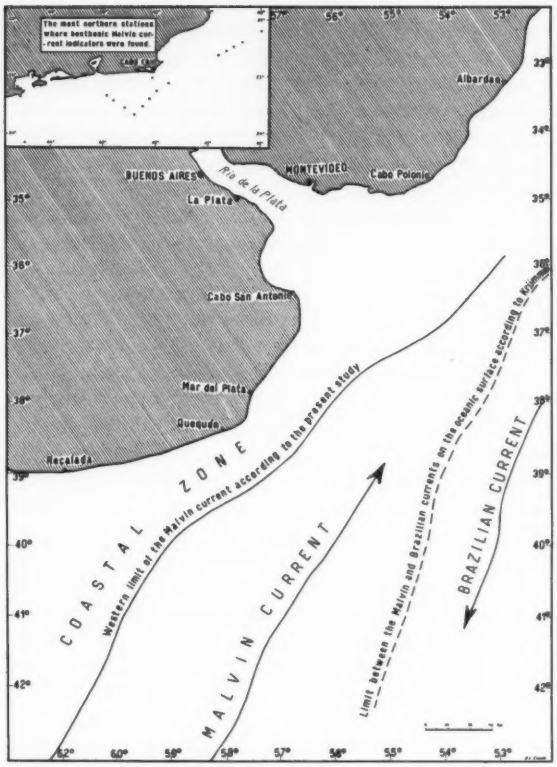
2) Concerning the boundaries of the various water masses, it can be stated that the first requirement for their determination is that the samples studied should be numerous and densely distributed. As can be seen from the enumeration of material available,

only the samples taken on the northern half of the Argentine shelf fulfill this demand. We shall therefore discuss the location of this boundary in the northern part of the Argentine epicontinental sea only. Analysis of the bottom samples taken in this area showed that they could be divided into four groups: 1) Those having only Malvinic species; 2) those containing forms of the same Malvinic type, not so qualitatively varied as above but nevertheless quantitatively abundant; 3) those having foraminiferal assemblages of the coastal-zone type, but with some rare isolated Malvinic species; and 4) those having species typical of the coastal zone only.

It was found that the geographic distribution of these groups on the Argentine shelf is rather regular. Only a few unimportant exceptions were observed. The samples with the typical Malvinic fauna occupy the most easterly part. The shallowest depth is 75 meters, but the majority of the samples were deeper than 90 meters, In the group next adjacent to the west, the average depth of the samples is between 80 and 90 meters, and the range of depth of the material is from 70 to 98 meters. The third group, that having the coastal fauna with isolated specimens of the Malvin Islands type, is situated still farther west. The shallowest depth where these isolated Malvinic species were encountered in the northern part of the Argentine shelf is 64 meters. This zone passes gradually into the typical coastal zone only the coastal-zone fauna was found.

The author believes that the stations where the samples with the assemblages of the first two groups were taken belong to the zone of the Malvin current proper. The extreme westerly stations containing these assemblages were determined on the basis of the material studied. They occupy the following geographic positions:

LATITUDE S.		LONGITUDE W.
36° 00′	.....	53° 05′
36° 30′	.....	53° 35′
37° 00′	.....	54° 15′
37° 30′	.....	55° 20′
38° 00′	.....	56° 00′
38° 30′	.....	56° 30′
39° 00′	.....	57° 05′
39° 30′	.....	58° 10′
40° 00′	.....	59° 00′
40° 30′	.....	59° 30′
41° 00′	.....	59° 55′
41° 30′	.....	60° 05′
42° 00′	.....	60° 25′
42° 30′	.....	60° 50′



TEXT-FIGURE 1

They are indicated on the accompanying map (text-fig. 1). This line represents the western boundary of the Malvin waters, which flow on the bottom in the northern part of the Argentine shelf. As mentioned above, this line corresponds more or less to the 80-meter isobath.

It was impossible to draw a similar western boundary for the surface water because no planktonic samples from the corresponding area were at the disposal of the author. However, it is believed that this surface boundary does not differ markedly from that at the bottom, because, in the samples where benthonic indicators were found, planktonic forms were also observed. It is well known that the distribution of planktonic forms on the surface generally corresponds rather well to the distribution of their empty tests on the bottom (Murray, 1897; W. Schott, 1935) unless as happens exceptionally, some special factors disturb it, or unless the depth is greater than that at which calcareous tests begin to dissolve.

It is believed that the stations where the coastal-zone assemblage with isolated Malvinic species was found belong to the zone of mixing of Malvin waters with those of the coastal zone. Concerning the eastern

limit of the Malvin current, it is impossible to define it on the bottom, as the depths are too great. At such depths the fauna becomes more or less uniform everywhere. Neither was it possible to define it on the ocean surface on the basis of foraminifera, since no planktonic material was available. This boundary, as represented on our map, was roughly drawn by Krümmel (1883) on the basis of temperature.

Thus we can see that the study of the foraminifera of the available samples has made it possible to define the western limit of the Malvin current, as well as to locate the zone of mixed waters. It is necessary, however, to emphasize the following points:

All ocean currents, including that of the Malvin Islands, are not constant in their characters within their limits. They change periodically, and these periods are of different durations. Some small variations are related to weather and the seasons, but those of longer periods ("rhythms") are connected with the general circulation of the whole hydrosphere and atmosphere. To obtain a picture of the momentary position of all the different masses of water in any area, we should study samples collected within as short a time as possible, and to obtain a general idea of the variable character of the movements of these masses, we should repeat this procedure at different seasons and over several years. It should also be taken into account that all the seas may change in time, and that these changes are not necessarily of a periodic character. Changes in their hydrographic properties logically entail changes in their populations. Sometimes this may happen rather rapidly, as was shown, for example, in the Kara Sea by the study of its zooplankton during the period from 1900 to 1946 (Ponomareva, 1957).

It is obvious that the material collected should be kept in neutralized formaldehyde to preserve the protoplasm from decomposition and thus to be able to tell subsequently which specimens of the benthonic species were alive at the time of their collection. The material studied in the present paper did not conform to this requirement. It was collected in most cases without formaldehyde, during different cruises in the course of several years. The material from each individual cruise would have been too meager for study. The samples were therefore treated provisionally as having been collected simultaneoulsy. As a consequence, we should consider the geographic limit obtained for the Malvin current not as representing its momentary position, but as the outer edge of the maximum distribution of the current reached during some undetermined number of years.

3) With respect to the problem of the area of origin of the main part of the Malvin waters, the preliminary conclusion may be drawn that, although the foraminiferal faunas of Cape Horn and the Malvin Islands are very similar, each has some distinct features. For example, the former fauna is characterized by a large number of *Discorbis isabelleana* (d'Orbigny) and *Anomalina vermiculata* (d'Orbigny), and in the latter fauna *Uvigerina bifurcata* d'Orbigny is abundant. In the samples collected on the Argentine shelf, extremely rare specimens of the first two species were found, but at the same time many specimens of *Uvigerina bifurcata* were also recorded. We can assume, therefore, that the Malvin waters of the area in question came mainly from the coasts of the Malvin Islands and not directly from Cape Horn, passing between the latter and the Malvin Islands. This conclusion certainly cannot claim to be infallible, however.

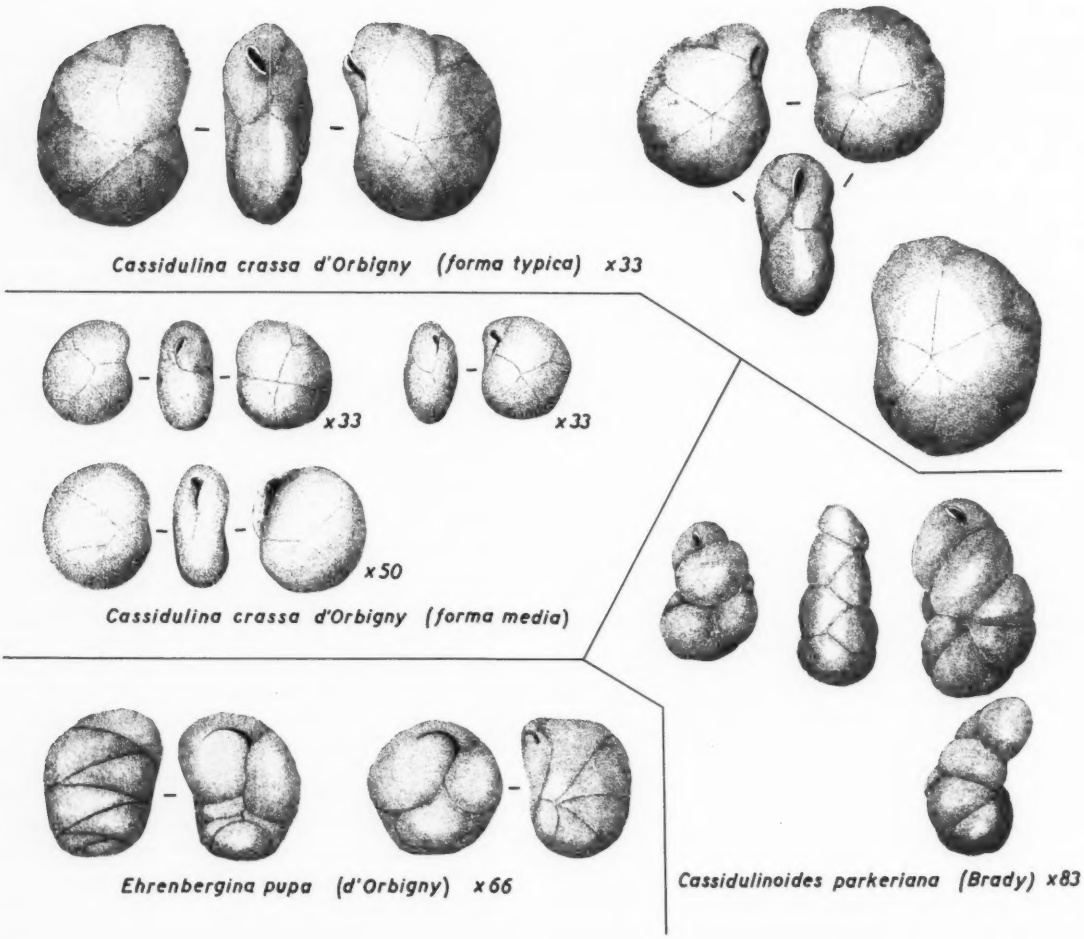
Concerning the most northerly point to which the Malvin current waters reach, the views published by different authors are contradictory. Many of them present no specific data, and their opinions are expressed without any details, bases, or explanations. The present study of the southern Brazilian bottom and plankton has made it possible to draw some conclusions, although provisional, on this as well.

The lowest latitude where *Ehrenbergina pupa* was encountered by the present author is 37° 30′ S. Brady recorded it from a station situated even farther north, at approximately lat. 35° S. Another Malvinic biological indicator, *Cassidulina crassa* (forma *media*), as well as some other cold-water forms, penetrate as rare individuals to the vicinity of Cabo Frio, approximately up to lat. 22° S. The corresponding stations are shown on the accompanying map. The most northerly station lies at lat 22° 10′ So. and long 40° 00′ W., at a depth of 99 meters.

Because not a single species was found in the Brazilian planktonic samples which is indigenous to sub-Antarctic waters, it is assumed that the remaining small portion of the end of the Malvin current reaches the latitude mentioned by spreading out only along the bottom, being covered by a layer of warm Brazilian water. Because no Malvinic indicators were found on the Brazilian shores, it is believed that the Malvin waters do not touch them, passing at some distance offshore. The relative scantiness of the available material does not make it possible to consider the conclusions regarding the problems enumerated in purpose 3 as definitive. Additional material is necessary to confirm them in detail.

FORAMINIFERA - BIOLOGICAL INDICATORS OF THE MALVIN CURRENT

BENTHONIC SPECIES



Cassidulina crassa d'Orbigny (forma typica) x33

Cassidulina crassa d'Orbigny (forma media)

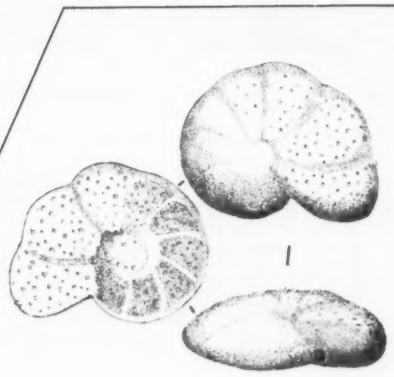
Ehrenbergina pupa (d'Orbigny) x66

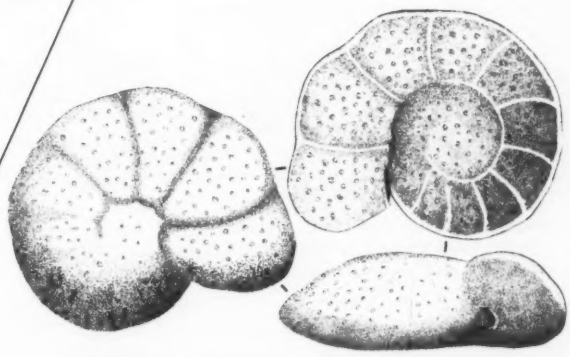
Cassidulinoides parkeriana (Brady) x83

BENTHONIC SPECIES

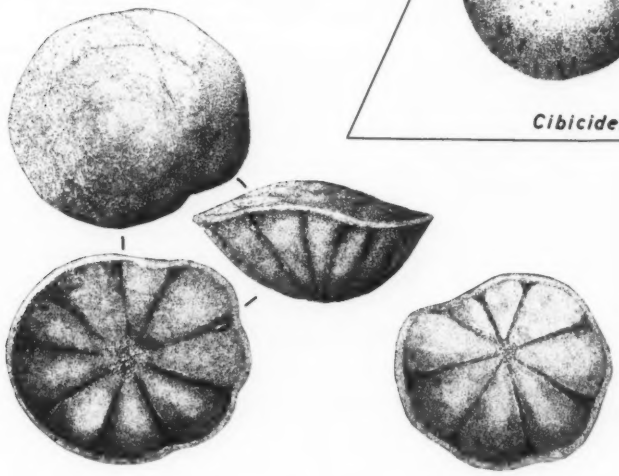
Uvigerina bifurcata d'Orbigny x43

Angulogerina angulosa (Williamson) x66

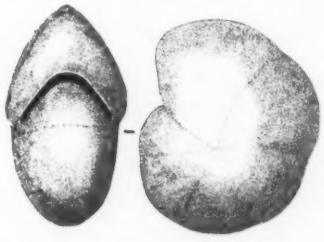




Cibicides aknerianus (d'Orbigny) x66

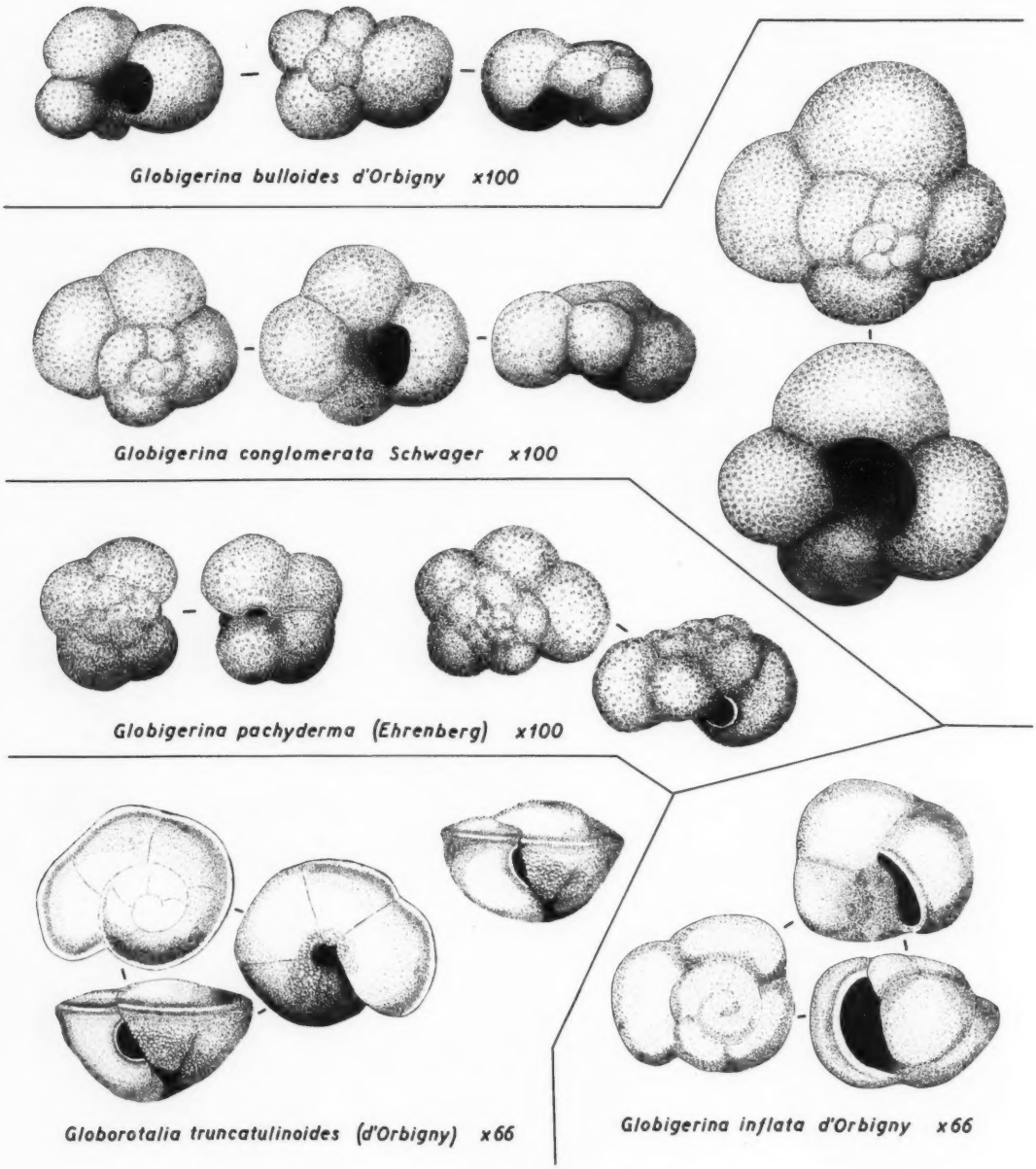


Buccella peruviana campsi (Boltovskoy) x66



Pullenia subcarinata subcarinata (d'Orbigny) x66

PLANKTONIC SPECIES



Globigerina bulloides d'Orbigny x100

Globigerina conglomerata Schwager x100

Globigerina pachyderma (Ehrenberg) x100

Globorotalia truncatulinoides (d'Orbigny) x66

Globigerina inflata d'Orbigny x66

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ABSTRACT: *Six bryozoan forms are described from the type locality of the Middle Miocene Bowden formation of Jamaica. All are new to the known Bowden assemblage, and one is believed to be a new species. The stratigraphic and geographic distribution of each of these forms is reviewed.*

Some species of Bryozoa new to the Bowden Beds, Jamaica, B.W. I.

R. LAGAAIJ
Wassenaar
The Netherlands

INTRODUCTION

The bryozoan assemblage of the Bowden Beds, now generally considered to be of upper Middle Miocene age (Woodring, 1928; 1943), was first made known by Canu and Bassler (1919), who described and figured seventeen species. This number was subsequently raised to thirty-two or thirty-three by the same authors (1923). The total number of species depends upon whether or not *Stylopoma minuta* Canu and Bassler, 1923, is identical with the form described by them in 1919 as *Stylopoma spongites* (Pallas). This is not clearly apparent from their 1923 monograph, in which no Bowden form was referred to *Stylopoma spongites*.

Through the courtesy of the Geological Survey, Kingston, Jamaica, I was able to examine a sample from the Bowden type locality for its Bryozoa. The sample was washed and sieved into several size-fractions, all of which were examined. In the course of this work the following forms that are new to the assemblage and deserve to be described were observed: *Nellia oculata* Busk, *Thalamoporella chubbi* Lagaaij, sp. nov., *Canda caraibica* Levinsen, *Crisia elongata* Milne-Edwards, *Crisia* spp., and *Crisulipora occidentalis* Robertson. Apart from *Thalamoporella chubbi* sp. nov., they all came from the finest fraction. In addition, the occurrence in this sample of the genera *Cellaria* and *Berenicea*, which are represented by one specimen each, and of numerous specimens of an erect, dichotomously branching cyclostome similar to *Tervia*, *Filisparsa*, or *Diaperoecia*, which, in the absence of gonozooecia, could not be identified even generically, is worthy of mention.

The types, figured specimens, and other material have been deposited in the Geological Department of the British Museum (Natural History), London, under the registration numbers D.41113–41346. Duplicates are kept in the collections of the Geological Survey, Kingston, Jamaica. Recent specimens from the Zoological Department of the British Museum (Natural History) are also referred to in the text by their registration numbers, which consist of four numbers separated by periods, e.g., 87.12.9.118. My thanks are due to the Director of the Geological Survey of Jamaica for supplying the Bowden sample; to the Keeper of the Department of Zoology in the British Museum (Natural History) for access to the collections and for other facilities; to Dr. H. Dighton Thomas and to Dr. Anna B. Hastings for reading and helpfully criticizing the typescript; and to Miss C. P. J. Roest for her fine illustrations for this paper.

SYSTEMATIC DESCRIPTIONS

Genus NELLIA Busk, 1852

Nellia oculata Busk
Text-figure 1

Nellia oculata BUSK, 1852, p. 18, pl. 64, fig. 6; pl. 65*(bis)*, fig. 4.
Nellia oculata Busk. – CANU AND BASSLER, 1919, p. 82, pl. 2, figs. 5–7.
Nellia oculata Busk. – CANU AND BASSLER, 1920, p. 196, pl. 82, figs. 6–10.
Nellia oculata Busk. – CANU AND BASSLER, 1923, p. 55, pl. 2, figs. 5–7.
Nellia oculata Busk. – CANU AND BASSLER, 1928, p. 26.
Nellia oculata Busk. – MCGUIRT, 1941, p. 66, pl. 2, fig. 5.

Material: B.M.(N.H.), reg. nos. D.41127–41206; eighty specimens, mounted on a slide, from the Bowden Beds at Bowden, Jamaica.

This well-known quadriserial species occurs commonly in the finest fraction of our material, well over 100

specimens (isolated internodes) having been obtained from a relatively small amount of washed residue. *Nellia oculata* is not new to the Antillean Miocene; it has been recorded from the Middle Miocene Cercado formation of Santo Domingo (Canu and Bassler, 1919; 1923). It also occurs in the Miocene of Florida (McGuirt, 1941). Only the original and the American fossil references are cited here. The Recent form is widely distributed throughout the tropical and subtropical latitudes, and has been recorded from Heard Island (lat. 53° S.) in the Indian Ocean.

Genus THALAMOPORELLA Hincks, 1887

Thalamoporella chubbi Lagaaij, **new species**
Text-figure 2a–c

Holotype: B.M.(N.H.), reg. no. D.41208, the specimen partly illustrated in text-fig. 2a, from the Bowden Beds at Bowden, Jamaica.

Paratypes: B.M.(N.H.), reg. nos. D.41209–41247; thirty-nine specimens, mounted on a slide, from the same locality.

Other material: B.M.(N.H.), reg. no. D.41248; eleven specimens, mounted on a slide, from the same locality.

Description: Zoarium erect, tubular, bifurcating, flattened at the dichotomy. *Zooecia* large, elongate-hexagonal or subrectangular, distinctly defined by their raised margins. *Opesia* large, subcircular, situated at the distal extremity of the zooecia, without visible condyles, and with a shallow crescentic vault distally. *Opesiules* large, elongate, often markedly unequal in size, both reaching the basal wall of the zooecium, where the insertion is open distally (text-fig. 2c). *Cryptocyst* with numerous distinct pores, distally inflected toward the opesiules and with thick, raised, granular margins. *Avicularia* large, symmetrical, always inserted at the base of a new row of zooecia, the rostrum rounded distally, with small proximal cryptocyst; the sister-zooecium not asymmetrical. *Ovicells* distinctly wider than long, the triangular orifice extending to little more than one-third of their length (text-fig. 2b).

Measurements:

Zooecia	Avicularia
Lz = 0.67–0.78 mm.	Lza = 0.72 mm.
lz = 0.42–0.48 mm.	lza = 0.29 mm.
ho = 0.20–0.23 mm.	
lo = 0.20–0.23 mm.	

This species is about half as common in the coarsest fraction of our material as the congeneric form *Thalamoporella biperforata* Canu and Bassler, 1919, from which it is easily distinguished. As all attempts to identify this form from the existing literature have been unsuccessful, the species is here described as *Thalamoporella chubbi* sp. nov., after Dr. L. J. Chubb, who collected and kindly sent me the material.

Among Recent species of *Thalamoporella* the affinities of *Thalamoporella chubbi* are clearly to be sought in the *granulata* group of Levinsen (1909). It particularly resembles *Thalamoporella tubifera* Levinsen (1909, p. 189, pl. 6a, fig. 2a–e) in the form of the avicularia and in the fact that both opesiules meet the basal wall, the insertion being open distally. It differs, however, from this Recent form in its erect, hollow-cylindrical growth, in the opesia not having a distinct proximal sinus, and in the more pronounced inequality of the opesiules, whose basal insertions also occupy a somewhat more proximal position on the basal wall than they do in *Thalamoporella tubifera*.

Genus CANDA Lamouroux, 1816

Canda caraibica Levinsen
Text-figure 3a–b

Canda simplex BUSK, 1884 (partim), p. 26 (not pl. 14, fig. 8).
Canda caraibica LEVINSEN, 1909, p. 142.
Canda caraibica Levinsen. – OSBURN, 1914, p. 192.
Canda caraibica Levinsen. – OSBURN, 1940, p. 387.
Canda caraibica Levinsen. – OSBURN, 1947, p. 22.

Material: B.M.(N.H.), reg. no. D.41207; one fragment, mounted on a slide, from the Bowden Beds at Bowden, Jamaica.

A scutum or trace of it is wanting in our specimen, and there are no spines or spine bases. Two Recent species of *Canda* are known from the West Indian region. One of these, *Canda retiformis* Pourtalès, has a scutum partly shielding the opesia, and is therefore of no direct interest here.

The other species, in which a scutum is absent, has been recorded under two different names, *Canda simplex* Busk and *Canda caraibica* Levinsen. *Canda simplex* Busk has "a very small spine at each upper angle [of the opesia]," and at least the lectotype specimen (B.M.(N.H.), reg. no. 87.12.9.118), from Challenger Station 44 (lat. 37° 25′ N., long. 71°40′ W.), taken in 1700 fathoms in blue mud, shows this character. The lectotype of *Canda simplex* is here chosen; according to Dr. Anna B. Hastings (*in litt.*), the original drawing shows that the Challenger figure (Busk, 1884, pl. 14, fig. 8) was made from material from this station. However, Busk's other original syntypes, from the Gulf of Mexico (reg. no. 99.7.1.829, 830), which were taken in 12 fathoms, are essentially without spines, and so are the specimens of *Canda caraibica* Levinsen in the Zoology Department of the British Museum (Natural History) (reg. no. 04.5.5.3, W. Indies, Exch[ange]. Dr. Levinsen; and reg. no. 32.4.12.2, off Montserrat, 12 fms.), and they are obviously all identical. It seems better, therefore, to distinguish Busk's non-spiniferous West Indian shallow-water form as *Canda caraibica* Levinsen. The Bowden specimen, being non-spiniferous, is also to be referred to this species. It is rather surprising to find that *Canda caraibica*, reported by three different authors in five different papers, has never before been figured.

Recent distribution:

Gulf of Mexico	12 fathoms
West Indies	
Tortugas Islands, Florida	15 fathoms
Guanica Harbor, Puerto Rico	3–17 fathoms
Cape la Vela, Colombia Aruba Caledonia Bay, Panama Gulf of Venezuela	11–71 fathoms
Off Montserrat	12 fathoms

Genus Crisia Lamouroux, 1812

Crisia spp.

Material: B.M.(N.H.), reg. nos. D.41250–41288; thirty-nine specimens, mounted on a slide, from the Bowden Beds at Bowden, Jamaica.

Some forty isolated internodes and fragments of internodes were obtained from the finest fraction. In view of the incompleteness of the specimens, and in the entire absence of gonozooecia, I shall not (with the following exception) attempt to identify them with Recent species. Possibly more than one species of *Crisia* is represented.

Crisia elongata Milne-Edwards
Text-figure 4

Crisia elongata Milne-Edwards, 1838, p. 203, pl. 7, fig. 2.
Crisia elongata Milne-Edwards. – Harmer, 1915, p. 96, pl. 8, figs. 1–8 *(cum syn.)*.
Crisia elongata Milne-Edwards. – Canu and Bassler, 1928, p. 157, pl. 30, fig. 3.
Crisia elongata Milne-Edwards. – Osburn, 1940, p. 328.
Crisia elongata Milne-Edwards. – Osburn, 1947, p. 3.

Material: B.M.(N.H.), reg. no. D.41249; one specimen, mounted on a slide, from the Bowden Beds at Bowden, Jamaica.

The large and almost complete internode measures 2.7 mm. in length, and is here figured (text-fig. 4). It has definitely more than eighteen, possibly twenty, zooecia, which are adnate over almost their entire length. The internode shows a well marked sigmoid flexure, with the basal articulation for a branch ("basis rami") on each convexity, the lower branch originally springing from the third zooecium on the right, and a second branch from the eighth zooecium on the left side of the internode. Thus, using Harmer's notation (1891, p. 146), this internode may be represented by the formula: (20? $+ r_3 +$ $_8r$). The dorsal surface is slightly convex, with striae marking the zooecial contours converging proximally at the median line.

Among the Recent forms that combine a similar general aspect with several of the characters given above, *Crisia elongata* Milne-Edwards should at once be mentioned (see Harmer, 1915, p. 98). Although the occurrence of internodes with an even number of zooecia is somewhat unusual in *Crisia*, they are a well known feature in *Crisia elongata*, in which they usually give rise to two branches.

Upon comparing this internode with Harmer's Siboga material of *Crisia elongata* in the Zoology Department of the British Museum (Natural History), such a close resemblance was found, in particular to the specimens from Siboga Station 282 (reg. no. 16.8.23.78), that there is good reason for referring it to the same species. Canu and Bassler's specimens from the Gulf of Mexico, Albatross Station D.2405, in the same Museum (reg. no. 32.3.7.100) were found to be generally larger, with wider internodes and larger zooecia. The only other fossil record of this species from the Central American region is from the Pliocene of Bocas Island, Almirante Bay, Panama (Canu and Bassler, 1928, p. 157).

Recent distribution: Circumtropical.

Genus Crisulipora Robertson, 1910

Crisulipora occidentalis Robertson
Text-figure 5

Crisulipora occidentalis Robertson, 1910, p. 254, pl. 21, figs. 22–24.
Crisulipora occidentalis Robertson. – Okada, 1917, p. 342.
Crisulipora occidentalis Robertson. – Marcus, 1937, p. 21, pl. 3, fig. 5.
Crisulipora occidentalis Robertson. – Osburn, 1953, p. 686, pl. 72, fig. 6.

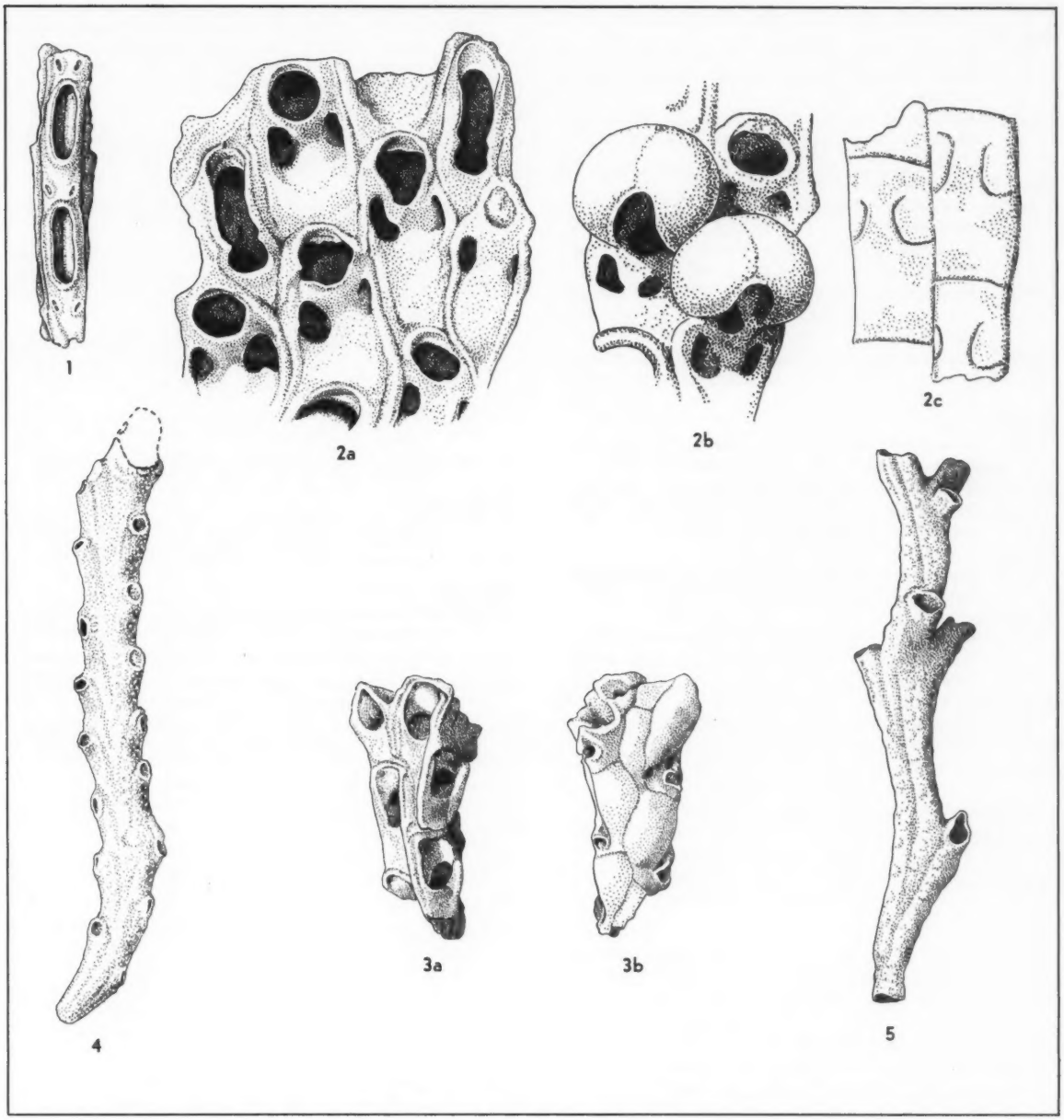
Material: B.M.(N.H.), reg. nos. D.41290–41317; twenty-eight specimens, mounted on a slide, from the Bowden Beds at Bowden, Jamaica.

Twenty-eight isolated internodes and fragments of internodes of the type here figured were collected from the finest fraction. Each internode bears only a small number of zooecia, with the irregularly arranged peristomes occurring on all sides. The proximal end of an internode always begins with one or two zooecial tubes, and then gradually widens distally by the intercalation of new zooecia. All specimens are proximal, nonfertile internodes.

Although no gonozooecia were found in the Bowden specimens, it is reasonably certain that they belong to Robertson's Recent California species, which has also been recorded from Japan and Brazil. They are strikingly similar to Recent nonfertile internodes from the Gulf of Mexico in my possession, and they also compare admirably with two Recent colonies of *Crisulipora occidentalis* from Santos, Brazil (reg. no. 1948.2.16.32), in the Zoology Department of the British Museum (Natural History).

Recent distribution:

American Pacific coast from Point Concepcion, California, to the Lobos de Afuera Islands, Peru	0–47 fathoms
Bay of Sagami, Japan	
Bay of Santos, Brazil	20 meters



TEXT-FIGURES 1–5

1, *Nellia oculata* Busk (reg. no. D.41127), fragment of an internode; 2, *Thalamoporella chubbi* Lagaaij, sp. nov.: a, holotype (reg. no. D.41208), part of zoarium with two avicularia; b, paratype (reg. no. D.41228), fragment with two ovicelled zooecia (partly reconstructed); c, paratype (reg. no. D.41215), dorsal aspect, showing the asymmetry of the basal insertions; 3, *Canda caraibica* Levinsen (reg. no. D.41207): a, frontal aspect; b, dorsal aspect of the same specimen; 4, *Crisia elongata* Milne-Edwards (reg. no. D.41249); the distal part of the internode, hidden by foreign material, is figured in outline only; 5, *Crisulipora occidentalis* Robertson (reg. no. D.41290), a fairly complete internode. All figures magnified × 40.

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BUSK, G.

1852 – *Catalogue of marine Polyzoa in the collection of the British Museum.* London: British Museum, vol. 1, pp. 1–54, pls. 1–68.

1884 – *Report on the Polyzoa: The Cheilostomata.* Rept. Voy. Challenger, Zool., vol. 10, pt. 30, pp. i–xxiv, 1–216, pls. 1–36.

CANU, F., AND BASSLER, R. S.

1919 – *Fossil Bryozoa from the West Indies.* Carnegie Inst. Washington, Publ., no. 291, pp. 73–102, pls. 1–7.

1920 – *North American early Tertiary Bryozoa.* U.S. Nat. Mus., Bull., no. 106, pp. 1–879, pls. 1–162.

1923 – *North American later Tertiary and Quaternary Bryozoa.* U.S. Nat. Mus., Bull., no. 125, pp. i–vii, 1–302, pls. 1–47.

1928 – *Fossil and Recent Bryozoa of the Gulf of Mexico region.* U.S. Nat. Mus., Proc., vol. 72, art. 14, pp. 1–199, pls. 1–34.

HARMER, S. F.

1891 – *On the British species of Crisia.* Quart. Jour. Micr. Sci., new ser., vol. 32, pp. 127–181, pl. 12.

1915 – *The Polyzoa of the Siboga Expedition; I – Entoprocta, Ctenostomata, and Cyclostomata.* Siboga Exped., Rept., no. 28a, pp. 1–180, pls. 1–12.

LEVINSEN, G. M. R.

1909 – *Morphological and systematic studies on the cheilostomatous Bryozoa.* Copenhagen. pp. i–vii, 1–431, pls. 1–24.

MARCUS, E.

1937 – *Bryozoarios marinhos Brasileiros; I.* São Paulo, Univ., Fac. Filos. Ciênc. Let., Bol., Zool., no. 1, pp. 1–162, 221–224, pls. 1–29.

MCGUIRT, J. H.

1941 – *Louisiana Tertiary Bryozoa.* Louisiana, Geol. Survey, Bull., no. 21, pp. i–xiii, 1–177, pls. 1–31.

MILNE-EDWARDS, H.

1838 – *Mémoire sur les crisies, les hornères et plusieurs autres polypes vivants ou fossiles dont l'organisation est analogue à celle des tubulipores.* Ann. Sci. Nat., Zool., ser. 2, vol. 9, pp. 193–238, pls. 6–16.

OKADA, Y.

1917 – *A report on the cyclostomatous Bryozoa of Japan.* Annot. Zool. Japon., vol. 9, no. 3, pp. 335–360.

OSBURN, R. C.

1914 – *The Bryozoa of the Tortugas Islands, Florida.* Carnegie Inst. Washington, Publ., no. 182, pp. 181–222.

1940 – *Bryozoa of Porto Rico, with a résumé of the West Indian bryozoan fauna.* New York Acad. Sci., Sci. Survey Porto Rico and Virgin Islands, vol. 16, pp. 321–486, pls. 1–9.

1947 – *Bryozoa of the Allan Hancock Atlantic Expedition, 1939.* Southern California, Univ., Publ., Allan Hancock Atlantic Exped., Rept., vol. 5, pp. 1–66, pls. 1–6.

1953 – *Bryozoa of the Pacific Coast of America; III – Cyclostomata, Ctenostomata, Entoprocta, and addenda.* Southern California, Univ., Publ., Allan Hancock Pacific Exped., vol. 14, no. 3, pp. 613–841, pls. 65–82.

ROBERTSON, A.

1910 – *The cyclostomatous Bryozoa of the West Coast of North America.* California, Univ., Publ., Zool., vol. 6, no. 12, pp. 225–284, pls. 18–25.

WOODRING, W. P.

1928 – *Miocene mollusks from Bowden, Jamaica; II – Gastropods and discussion of results.* Carnegie Inst. Washington, Publ., no. 385, pp. i–vii, 1–564, pls. 1–40.

1943 – In: COOKE, C. W., GARDNER, J., AND WOODRING, W. P., *Correlation of the Cenozoic formations of the Atlantic and Gulf Coastal Plain and the Caribbean region.* Geol. Soc. Amer., Bull., vol. 54, pp. 1713–1722.

ABSTRACT: *One hundred and twenty papers on all aspects of micropaleontology are listed and briefly reviewed.*

Annotated bibliography of micropaleontology in Germany for 1958

HEINRICH HILTERMANN
Bundesanstalt für Bodenforschung
Hannover

This is a continuation of the bibliography published last year in MICROPALEONTOLOGY (1958, vol. 4, no. 4, pp. 431–438). As before, it is restricted to papers that are concerned with micropaleontology and microstratigraphy or which mention microscopic fossils. In addition to foraminifera, this bibliography covers ostracodes, Radiolaria, and other animal microfossils, as well as microscopic fragments of larger organisms and fossil plant remains. Papers that are important in taxonomy are marked with an asterisk.

AVERDIECK, F. R.

*1958 – *Pollen vom Chenopodiaceen-Typ im Flöz Frimmersdorf – ein Hinweis auf seine strandnahe Entstehung.* Fortschr. Geol. Rheinland Westf., vol. 1, pp. 101–112, 2 pls., 1 text-fig., 2 tables.
Illustration, distribution, and ecology of the pollen found at the base of a brown coal seam.

BARTENSTEIN, H.

1958*a* *Die Bedeutung der Mikropaläontologie für die Erdölindustrie.* In: FREUND, H., *Handbuch der Mikroskopie in der Technik.* Frankfurt a. M.: Vol. 2, pt. 3 (Mikropaläontologie), pp. 63–81, 13 text-figs.
The close relations between science and the practice of petroleum geology are indicated; in addition to the evaluation of shallow and deep drilling, remarks are given concerning the applications of micropaleontology in mapping and electric logging.

1958*b* *Alttertiäre Mikrofaunen aus dem Reinhardswald, ein Beitrag zur Frage der Südverbreitung des marinen prä-Mitteloligozäns.* Hessen, Landesamt Bodenf., Notizbl., vol. 86, pp. 269–280, 1 text-fig., 2 pls.
Photographs, lists of foraminifera and ostracodes, and paleogeographic evaluation of five new Oligocene localities of northern Kassel.

1958*c* *Bemerkungen zu den Münster'schen neuen Foraminiferen-Arten in* F. A. Roemer "*Die Cephalopoden des Nord-Deutschen tertiären Meeressandes" (1838).* Hessen, Landesamt Bodenf., Notizbl., vol. 86, pp. 279–280.
According to the IRZN, the author of thirty-three Oligocene species is Roemer and not von Münster.

BECKMANN, H.

1958 – *Arbeitstechniken und Erfahrungen der Mikropaläontologie im Paläozoikum.* In: FREUND, H., *Handbuch der Mikroskopie in der Technik.* Frankfurt a. M.: Vol. 2, pt. 3 (Mikropaläontologie), pp. 147–165, 3 text-figs., 2 pls.
Methods for isolating microscopic fossils from solid calcareous and siliceous rocks when the fossils are weaker than or chemically identical with the surrounding rock, especially with regard to conodonts.

BETTENSTAEDT, F.

*1958*a* *Phylogenetische Beobachtungen in der Mikropaläontologie.* Pal. Zeitschr., vol. 32, pp. 115–140, 3 text-figs.
Phylogeny of *Globorotalites*, *Bolivinoides*, and *Cytherelloidea* in the Cretaceous of northwestern Germany, with a discussion of the interrelations between selection and evolution.

1958*b* *Zur stratigraphischen und tektonischen Gliederung von Helvetikum und Flysch in den Bayerischen und Vorarlberger Alpen auf Grund mikropaläontologischer Untersuchungen.* Deutsch. Geol. Ges., Zeitschr., vol. 109, pp. 566–592, 1 text-fig., 3 tables.
Stratigraphic division based on foraminifera and ostracodes from 1500 samples. New classification of the Barremian to Eocene strata, and tectonic conclusions.

BISCHOFF, G., AND SANNEMANN, D.

*1958 – *Unterdevonische Conodonten aus dem Frankenwald.* Hessen, Landesamt Bodenf., Notizbl., vol. 86, pp. 87–110, 3 text-figs., 4 pls.
From the tentaculite limestone and its basal transgressive beds, 42 species of conodonts, including nine new ones, and the new genus *Ancyrodelloides*, are described.

BRELIE, G. VON DER

*1958*a* *Sporen und Pollen im marinen Tertiär der Niederrheinischen Bucht.* Fortschr. Geol. Rheinland Westf., vol. 1, pp. 185–204, 2 text-figs., 1 pl., 1 table.
Lists, with vertical ranges, indicate that sporomorphs do not permit exact discrimination between the Upper Oligocene and the Middle Miocene, although they do between the Middle and Upper Oligocene. Hystrichospherids in brown coal show a marine influence.

1958*b* *Palynologische Untersuchungen zur Altersstellung des Braunkohlen-Vorkommens von Kayi-Bucuk (Vilâyet Ankara).* Maden Tetkik ve Arama Enstitüsü (Mining Research and Exploration Institute of Turkey), Bull., no. 50, pp. 27–32, 1 text-fig., 1 table.
Twenty-three types of pollen and spores found in seven samples from a small brown coal seam are named. The age is determined as Upper Miocene.

BRELIE, G. VON DER, AND REIN, U.

1958 – *Die stratigraphische Einstufung der Braunkohlenflöze im Tagebau Düren.* Fortschr. Geol. Rheinland Westf., vol. 2, pp. 555–562, 4 text-figs.
Palynological classification of the main seam of the Rhenish brown coal as Helvetian-Tortonian.

BRELIE, G. VON DER, AND WOLTERS, R.

1958 – *Das Alttertiär von Gürzenich westlich Düren.* Fortschr. Geol. Rheinland Westf., vol. 2, pp. 473–478, 1 text-fig.
A 50-meter section containing brown coal seams is assigned to the Upper Oligocene on the basis of sporomorphs.

BROSIUS, M.

1958*a* *Tegelen-Braunkohle von Fürstenhagen bei Hessisch-Lichtenau.* Hessen, Landesamt Bodenf., Notizbl., vol. 86, pp. 316–319, 2 text-figs.
Brief mention of pollen, with generic names.

1958*b* *Geologische und pollenanalytische Untersuchungen in der Tertiärmulde von Glimmerode/Hess.-Lichtenau.* Deutsch. Geol. Ges., Zeitschr., vol. 109, p. 668 (abstract).
Microfaunal and palynological data concerning the stratigraphy of Eocene to Miocene beds.

DECHEND, W.

1958 – *Marines und brackisches Eem im Raum der Ems-Mündung.* Geol. Jahrb., vol. 76, pp. 175–190, 4 text-figs., 2 tables.
The Eemian is shown to be present in all of the Ems River estuaries. Diatoms (eighty-three species), foraminifera (six species), ostracodes (four species), pelecypods (forty-one species), and gastropods (fourteen species) were found in the Eemian deposits and are named.

DIETZ, C., GRAHLE, H. O., AND MÜLLER, H.

1958 – *Ein spätglaziales Kalkmudde-Vorkommen im Seck-Bruch bei Hannover.* Geol. Jahrb., vol. 76, pp. 67–102, 9 text-figs.
Diagrams and lists of pollen and small mollusks from 2-meter sections through the late glacial tundra bed.

DIETZ, C., HILTERMANN, H., AND SCHMID, F.

1958 – *Exkursion in die Kreide- und Tertiäraufschlüsse der Kronsberg-Mulde östlich Hannover.* Deutsch. Geol. Ges., Zeitschr., vol. 109, pp. 332–335, 2 text-figs.
References to outcrops that are important in biostratigraphy, at Gleidingen (upper Santonian), Moorberg (Barremian, Aptian, Albian), Wehmingen (terrestrial Paleocene), and Misburg (Cenomanian to upper Campanian).

DÖBLING, H., AND SCHÜRMANN, M.

1958 – *Mittelmiozän und Oberoligozän an der unteren Lippe.* Fortschr. Geol. Rheinland Westf., vol. 1, pp. 265–268, 1 text-fig.
List of fossils, including foraminifera, found in trenches and shallow wells.

DOEBL, F.

1958*a* *Stratigraphische und paläogeographische Ergebnisse neuerer mikropaläontologischer Untersuchungen im Tertiär des Rheintalgrabens.* Erdöl und Kohle, vol. 11, pp. 373–376, 1 text-fig., 2 pls.
Stratigraphy of the Eocene to Aquitanian of the Rhine Valley graben, with special reference to micropaleontology, including foraminifera and ostracodes, and paleogeographic conclusions.

1958*b* *Ergebnisse mikropaläontologischer Untersuchungen im Rheintalgraben.* Deutsch. Geol. Ges., Zeitschr., vol. 109, p. 671 (abstract).
Bionomic stratigraphy, with brief notes on foraminifera, ostracodes, and charophytes.

DREXLER, E.

*1958 – *Foraminiferen und Ostracoden aus dem Lias alpha von Siebeldingen/Pfalz.* Geol. Jahrb., vol. 75, pp. 475–554, 25 text-figs., 8 pls.

An 18.3-meter section containing four zones of ammonites is described. The microfauna is described and illustrated, comprising thirty-two foraminifera and twenty-four ostracodes, the latter with thirteen new species and one new subspecies. The vertical ranges of twelve ostracodes and sixteen foraminifera are given. The development of *Ogmoconcha hagenowi*, n. sp., is analyzed statistically. The relationship between calcium carbonate content and microfossils is discussed.

EISENACK, A.

*1958 – *Tasmanites Newton 1875 und Leiosphaeridia n.g. als Gattungen der Hystrichosphaeridea.* Palaeontographica, vol. 110, pt. B, pp. 1–19, 3 text-figs., 2 pls.
Cutin balls with smooth or spinose surfaces, formerly believed to be partly plant spores, are classified together in the family Leiosphaeridae; their characteristics are discussed. *Tamamites* and *Leiosphaeridia*, with ten species, three of which are new, are described from the Mesozoic and especially the Paleozoic.

ELLERMANN, C.

1958 – *Die mikrofaunistische Gliederung des Oligozäns im Schacht Kapellen bei Moers.* Fortschr. Geol. Rheinland Westf., vol. 1, pp. 205–214, 3 pls., 3 tables.
Vertical ranges of fifty-six foraminifera and thirty-eight ostracodes from a 192-meter section of the Oligocene are given.

FABIAN, H. J.

1958 – *Die Aufschlußbohrung Straeten 1 und ihre Bedeutung für die Gliederung des Tertiärs im südlichen Teil der Niederrheinischen Bucht.* Fortschr. Geol. Rheinland Westf., vol. 1, pp. 11–28, 1 text-fig., 1 pl., 1 table.
Subdivision of a 1200-meter section of the Tertiary, primarily by means of mollusks but partly also by sporomorphs from the brown coal, with thirty-three species named.

FAHRION, H.

1958 – *Die Tertiär-Profile einiger Erdölbohrungen im nördlichen Teil der Niederrheinischen Bucht.* Fortschr. Geol. Rheinland Westf., vol. 1, pp. 1–10, 1 text-fig., 1 table.
Subdivision of sections in four wells penetrating the Miocene, Oligocene, and Paleocene, based on mollusks and foraminifera.

FRICKE, K., AND SCHÜRMANN, M.

1958 – *Das Oligozän-Profil von Uerdingen-Hohenbudberg bei Krefeld.* Fortschr. Geol. Rheinland Westf., vol. 1, pp. 259–264, 1 text-fig., 2 tables.
Vertical ranges of mollusks found in two borings, and reference to foraminifera.

GEYER, O. F.

1958 – *Über Schwammnadeln aus dem Weißen Jura von Würgau (Oberfranken).* Naturf. Ges. Bamberg, Ber., vol. 36, pp. 9–14, 3 text-figs.
Description and illustration of fourteen different isolated spicules of Silicospongia from the Upper Jurassic.

GÖKE, G.

1958*a* *Die Gewinnung und Präparation der fossilen Foraminiferen.* Mikrokosmos, vol. 47, pp. 77–82, 8 text-figs.
Remarks on the preparation of foraminifera.

1958*b* *Einführung in die Präparation der fossilen Diatomeen.* Der Aufschluß, pp. 12–16; pp. 40–43, 12 text-figs.
Methods of isolating diatoms from various rocks, picking, and mounting them.

GOERLICH, F.

1958 – *Die stratigraphische Verbreitung und fazielle Bedeutung der Ostracoden im marinen Oligozän von Rossenray bei Rheinberg (Niederrhein).* Fortschr. Geol. Rheinland Westf., vol. 1, pp. 215–222, 1 table.
Vertical ranges and ecology of forty-two ostracodes found in a 230-meter section through the Middle and Upper Oligocene.

GRAHLE, H. O., AND SCHNEEKLOTH, H.

1958 – *Ein Holstein–Interglazial in Kiesen der Uelsener Stauchzone bei Wilsum (Gft. Bentheim).* Geol. Jahrb., vol. 76, pp. 199–208, 1 text-fig., 1 table.
Diagrams of pollen and *Azolla* indicate a Holstein interglacial age, with Atlantic influence.

GREILING, L.

1958 – *Graptolithen-Erhaltung in "weißer Kieselsäure."* Senckenbergiana Lethaea, vol. 39, pp. 289–299, 1 text-fig., 2 pls.
Illustrations of graptolites from the Gotlandian of the Frankenwald preserved as white silicates.

GRELL, K. G.

1958*a* *Untersuchungen über die Fortpflanzung und Sexualität der Foraminiferen; II – Rubratella intermedia.* Archiv Protistenk., vol. 102, pp. 291–308, 3 text-figs., 12 pls.
Ontogeny of *Rubratella intermedia*, n.g., n. sp.; cytological investigations, with drawings and microphotographs, show the gametogamy of the same or different gamonts, and, in the other generation, the somatic and generative nucleoles and their special development toward "extrathalamous" agamonts.

1958*b* *Untersuchungen über die Fortpflanzung und Sexualität der Foraminiferen; III – Glabratella sulcata.* Archiv Protistenk., vol. 102, pp. 449–472, 6 text-figs., 7 pls.

Description and illustration of the cytological ontogeny of a haploid foraminifera with nine chromosomes. Description of syngamy is included. Different numbers of dextrally and sinistrally coiled specimens are present in both generations.

1958*c* *Studien zum Differenzierungsproblem an Foraminiferen.* Die Naturwiss., vol. 45, pp. 25–32, 12 text-figs.
Description of the cytological ontogeny of the nucleus of six foraminifera. Microspheric agamonts and megalospheric gamonts were observed only in species with free-swimming gamonts.

GROSPIETSCH, T.

1957 – *Wechseltierchen (Rhizopoden).* Stuttgart: 80 pp., 73 text-figs., 4 pls.
Morphology, taxonomy, biology, ecology, and preparation of limnic rhizopods, with over 250 specimens figured.

GROSS, W.

*1958 – *Anaspiden–Schuppen aus dem Ludlow des Ostseegebietes.* Pal. Zeitschr., vol. 32, pp. 24–37, 5 text-figs., 3 pls.
Detailed observations on the growth, histology, blood vessels, and sculpture of scales of Silurian Anaspida from Oesel and from the *Beyrichia* Limestone.

HAGN, H.

1958 – *Mikropaläontologische Untersuchungen an Gesteinen der Insel Kephallinia (Adriatisch–Jonische Zone Griechenlands).* Athens, Univ., Lab. Géol., Ann. Géol. Pays Helléniques, vol. 46, pp. 89–114, 1 pl.
Discussion of stratigraphic and lithological problems on the basis of eight thin sections and four washing residues, with lists of larger and smaller foraminifera. According to an appendix by C. W. DROOGER, the *Miogypsina* limestones are to be assigned to the Helvetian–Tortonian transition.

HELAL, A. H.

1958 – *Das Alter und die Verbreitung der tertiären Braunkohle von Bergisch Gladbach.* Fortschr. Geol. Rheinland Westf., vol. 2, pp. 419–436, 6 text-figs.
Palynological interpretation and lists of fossils from the Oligocene brown coal to the east of Cologne.

HILTERMANN, H.

1958*a* *Annotated bibliography of micropaleontology in Germany for 1957.* Micropaleontology, vol. 4, no. 4, pp. 431–438.
One hundred one papers on all aspects of micropaleontology are listed and briefly reviewed.

1958*b* *Aus der Geschichte der angewandten Mikropaläontologie.* In: FREUND, H., *Handbuch der Mikroskopie in der Technik.* Frankfurt a. M.: Vol. 2, pt. 3 (Mikropaläontologie), pp. 3–13, 4 pls., 36 portr.
Short historical review of the stratigraphic application of foraminifera, ostracodes, radiolarian, pollen, and other microfossils, together with thirty-six portraits of micropaleontologists, most of which have not previously been published.

1958*c* *Anwendung der Mikropaläontologie in der Geologie, entwickelt durch die Erdölgeologie.* In: FREUND, H., *Handbuch der Mikroskopoie in der Technik.* Frankfurt a. M.: Vol. 2, pt. 3 (Mikropaläontologie), pp. 15–60, 23 text-figs., 2 pls., 1 table.
Instructions for collecting rock samples, together with remarks on the occurrence of microfossils; eight methods of treating solid rocks; investigation and storage of washed residues; instructions on the evaluation of microscope data, with reference to the nomenclature and representation of the quality and quantity of the fossils.

1958*d* *Spezielle Arbeitsgebiete der Mikropaläontologie; 1 – Foraminiferen.* In: FREUND, H., *Handbuch der Mikroskopie in der Technik.* Frankfurt a. M.: Vol. 2, pt. 3 (Mikropaläontologie), pp. 169–189, 7 text-figs., 1 table.
Systematic methods of procedure in the taxonomy and morphologic analysis of foraminifera. Examples of phylogenetic studies are discussed, including complete vertical sequences of species of *Bolivinoides, Vaginulina, Globorotalites, Neoflabellina, Uvigerina,* and *Globorotalia.*

1958*e* *News report – Germany.* Micropaleontology, vol. 4, no. 2, pp. 218–219.
References to various publications, lectures, meetings and excursions.

1958*f* *Allochthone Foraminiferen in den Neurather Sanden und in einem Zwischenmittel in Flöz Frimmersdorf.* Fortschr. Geol. Rheinland Westf., vol. 1, pp. 159–164, 1 text-fig., 1 pl.
Names and photographs of eighteen allochthonous foraminifera in limnic younger Tertiary.

HÖLDER, H.

1958 – *Seltsame Nummuliten–Packungen.* Neues Jahrb. Geol. Pal., Monatshefte, pp. 378–379, 1 text-fig.
Note on specimens standing vertically and closely packed in rows.

HOFKER, J.

*1958 – *Daviesina voigti n. sp., eine gesteinsbildende Foraminifere aus dem Campan des subherzynen Beckens.* Hamburg, Geol. Staatsinst., Mitt., vol. 27, pp. 69–73, 5 text-figs.
A new name for a large foraminiferal species that is common in the "Quadraten–Trülumerkreide" of Wernigerode, which had previously been called *Amphistegina fleuriausi* d'Orbigny.

HUCKRIEDE, R.

*1958*a* – *Die Conodonten der mediterranen Trias und ihr stratigraphischer Wert.* Pal. Zeitschr., vol. 32, pp. 141–175, 1 text-fig., 5 tables.
Forty species (thirteen new) are described from fifty-eight localities, with figures and vertical ranges. Discussion of ecologic and zoogeographic problems concerning these peculiar Triassic Tethys conodonts.

1958*b* – *Die Kreideschiefer bei Kaisers und Holzgau in Lechtaler Alpen (Apt–Unteres Cenoman).* Austria, Geol. Bundesanst., Verh., no. 1, pp. 71–86, 1 text-fig.
Discussion of some sections containing foraminifera which provide new stratigraphic information.

HUCKRIEDE, R., AND JACOBSHAGEN, V.

1958 – *Der Fundplatz des Menschenschädels von Rhünda (Niederhessen).* Neues Jahrb. Geol. Pal., Monatshefte, pp. 114–129, 2 text-figs.
Ecologic interpretations based on five species of Quaternary ostracodes.

HUSTEDT, F.

1958 – *Präparation und Untersuchungsmethoden fossiler Diatomeen.* In: FREUND, H., *Handbuch der Mikroskopie in der Technik.* Frankfurt a. M.: Vol. 2, pt. 3 (Mikropaläontologie), pp. 427–450, text-figs. 10.
Technical discussion of the treatment of raw material, methods of selection, investigation, and photography of diatoms; the preparation of strew slides, single preparations, and type plates are treated.

INDANS, J.

1958 – *Mikrofaunistische Korrelationen im marinen Tertiär der Niederrheinischen Bucht.* Fortschr. Geol. Rheinland Westf., vol. 1, pp. 223–238, 3 text-figs., 8 pls.
Photographs of microfaunas from the Paleocene, Middle and Upper Oligocene, and Middle Miocene. Vertical range tables of foraminifera from two sections of about 250 meters.

JUX, U., AND PFLUG, H. D.

1958*a* *Über Aufbau und Altersgliederung des Rheinischen Braunkohlenbeckens.* Geologie, vol. 7, 48 pp., 11 text-figs.
Vertical ranges of the foraminifera and mollusks of three Oligocene well sections. Correlation of these data with palynological findings in outcrops of lignite and with electric logs. Discussion of paleogeographic and tectonic data, with the conclusion that the lignites are also to be classified as Oligocene.

1958*b* *Altersbeziehungen festländischer und mariner Fazies im Tertiär der Niederrheinischen Bucht.* Neues Jahrb. Geol. Pal., Monatshefte, vol. 6, pp. 243–255, 3 text-figs.
On the basis of the presence of *Elphidium subnodosum* in sands containing deposits of brown coal, it may be assumed that the brown coal, which hitherto has been classed as Miocene, is of Upper Oligocene age; palynological results do not contradict this assumption.

KAEVER, M.

*1958 – *Über Globorotalites Brotzen 1942 und Conorotalites nov. gen.* Geol. Jahrb., vol. 75, pp. 433–436, 2 text-figs.
Species of Lower Cretaceous age formerly classified as *Globorotalites* are separated as a new genus, on the basis of the wall structure and internal character.

KNAUFF, W.

1958 – *Untersuchungen an Foraminiferen aus dem Lias delta.* Pal. Zeitschr., vol. 32, pp. 5–6 (abstract).
Discussion of the taxonomy of some Liassic Lagenidae; mention of *Praeophthalmidium.*

KOCKEL, F.

1958 – *Conodonten aus dem Paläozoikum von Malaga (Spanien).* Neues Jahrb. Geol. Pal., Monatshefte, vol. 6, pp. 255–263, 1 text-fig.
Lists of conodonts from eleven localities, were given; on this basis limestones can be classified as Wenlockian and Ludlovian in the Ordovician, and as Ems and Eifelian in the Devonian.

KOLOSVARY, G.

*1958 – *Ein neuer operculater Cirripedier aus der Kreide.* Pal. Zeitschr., vol. 32, pp. 38–39, 1 pl.
Description and illustration of *Schroteriella cenomanica* n.g., n. sp., from the Cenomanian of Bozovicz (Siebenbürgen).

KRAATZ, R.

*1958 – *Stratigraphische und paläontologische Untersuchungen (besonders im Gotlandium) im Gebiet zwischen Wieda und Zorge (südl. Westharz).* Deutsch. Geol. Ges., Zeitschr., vol. 110, pp. 22–66, 13 text-figs., 4 tables, 3 pls.
Revision based on variation statistics of twenty-two species of *Monograptus,* with two new species and two new subspecies, and description of *Cyrtograptus polykladus,* n. sp.

KREBS, W.

1958 – *Dillenburger Tuffe.* Hessen, Landesamt Bodenf., Notizbl., vol. 86, pp. 140–152.
A tuff facies of the Buchenauer beds is named the "Dillenburger Tuffe." It is dated as low Upper Devonian, principally by conodonts.

KRÖMMELBEIN, K.

*1958 – *Ostracoden aus dem Unteren Zechstein der Bohrung Leba in Pommern.* Geol. Jahrb., vol. 75, pp. 115–134, 4 text-figs., 3 pls.
New description and illustration of ten ostracode species of *Monoceratina?*, *Roundyella*, *Healdia*, *Waylandella*, *Bairdiocypris?*, *Pachydomella*, and *Bairdia* from three Permian well samples.

KÜHNE, W. G.

*1958 – *Rhaetische Triconodonten aus Glamorgan, ihre Stellung zwischen den Klassen Reptilia und Mammalia und ihre Bedeutung für die Reichart'sche Theorie.* Pal. Zeitschr., vol. 32, pp. 197–235, 27 text-figs.
Isolated teeth up to 1 or 2 mm. in size of *Morganucodon watsoni* from the Rhaetic are described and figured. Discussion of morphologic, taxonomic, and phylogenetic problems.

LESCHIK, G.

1958 – *Sporenstratigraphie im Perm und in der Trias.* Deutsch. Geol. Ges., Zeitschr., vol. 110, pp. 13–14 (abstract).
Lists of megaspores from the Dwyka beds (South Africa), and the Zechstein and Keuper of Europe; reference to a few spores from the Bunter and Muschelkalk.

MÄDLER, K.

1957 – *Fossil Charophytes, their evolution, taxonomy and stratigraphy.* Pal. Soc. India, Jour., pp. 42–47, 2 tables.
Fossil oogonia are stratigraphically useful, especially in brackish-water sediments. Attempt to outline their development.

1958*a* *Charophyten.* In: FREUND, H., *Handbuch der Mikroskopie in der Technik.* Vol. 2, pt. 3 (Mikropaläontologie), pp. 283–287, 1 pl.
Morphology and methods of investigation of charophytes; table of the vertical ranges of forty-four oogonia ranging from the Devonian to the Quaternary.

1958*b* *Neue mikrobotanische Untersuchungen im Posidonienschiefer.* Pal. Zeitschr., vol. 32, pp. 13–14 (abstract).
Most of the matrix of the Liassic Posidonia shale consists of algae 10–20μ in size.

1958*c* *Über mesozoische Vertreter der Gattung Concavisporites.* Pal. Zeitschr., vol. 32, p. 14 (abstract).
Narrow restriction of *Concavisporites* based on the genotype.

1958*d* *Zur Einzelkornpräparation fossiler Sporomorphen.* Pal. Zeitschr., vol. 32, p. 14 (abstract).
Simplifying palynological preparation by means of multigrain slides.

MAIER, D.

*1958*a* *Coccolithophorideen aus dem niederrheinischen Tertiär.* Fortschr. Geol. Rheinland Westf., vol. 1, pp. 179–184, 1 text-fig., 1 table.
Characteristics of twelve coccoliths from the Middle and Upper Oligocene, and their evaluation with regard to climate.

1958*b* *Zur Gliederung des Tertiär mit Hystrichosphaerideen.* Neues Jahrb. Geol. Pal., Monatshefte, vol. 10, pp. 468–472.
Brief preliminary note on the distribution of Hystrichosphaeridea in the Tertiary of northwestern Germany.

MAIER, D., AND WETZEL, W.

1958 – *Fluoreszensmikroskopie geologischer und paläontologischer Objekte.* Zeiss Mitteilungen, vol. 1, pp. 127–131, 6 text-figs.
Brief report, with a color photograph, on an Albian foraminifer with veinlets.

MAIER, W.

1958 – *Glaukonitische Mikrofossilien aus dem alpinen Eozän von Rohrdorf.* Deutsch. Geol. Ges., Zeitschr., vol. 109, pt. 2, pp. 448–451, 2 text-figs.
Thin sections of calcareous sandstones show structures like corals and sponges.

MALZ, H.

*1958*a* *Nodophthalmocythere n. gen. (Ostrac., Ob. Jura), nebst einer Abgrenzung gegen ähnliche Gattungen.* Senckenbergiana Lethaea, vol. 39, pp. 119–133, 3 pls.
Description of a new genus and its differences from similar genera such as *Schuleridea*, with *N. vallata*, n. sp., and *N. tripartita*, n. sp., from the Kimmeridgian of France, England, and Germany. The marginal areas, hinges, and eye tubercles are discussed and figured in particular detail.

*1958*b* *Die Gattung Macrodentina und einige andere Ostracoden-Arten aus dem Oberen Jura von NW-Deutschland, England und Frankreich.* Senckenberg. Naturf. Ges., Abh. no. 497, pp. 1–44, 11 pls., 4 text-figs., 3 tables.
Taxonomic revision of *Macrodentina*, with the subgenera *Macrodentina*, *Dictyocythere*, and *Polydentina* (n. subgen.), and detailed description of thirty-one species, of which sixteen are new. Definition of *Rectocythere*, n. gen., with *R. inglandiformis* and *R. regularis* (n. sp.), and of the new species *Mandelstamia rectilineata* and *Protocythere bireticulata.* Vertical ranges of the species.

MARTIN, G. P. R.

*1958*a* *Cetacella, eine neue Ostracoden-Gattung aus dem Kimmeridge Nordwestdeutschlands.* Pal. Zeitschr., vol. 32, pp. 190–196, 1 pl.
Description and illustration of *Cetacella*, n. gen., with *C. armata*, n. sp., and *C. inermis*, n. sp., of which the latter is an index fossil of the lower Kimmeridgian. Comparison with similar forms from the Morrison formation.

*1958*b* *Über die systematische Stellung der Gattung Cypridea Bosquet (Ostracoda), nebst Beschreibung der Wealden-Basis-Ostracode C. buxtorfi n. sp.* Neues Jahrb. Geol. Pal., Monatshefte, pp. 312–320, 1 text-fig.
Redescription of *Cypridea*; reduction of *C. mammillata* to *C. fasciculata* var. *mammillata*. Description of *C. buxtorfi*, n. sp.

1958*c* *Eine Foraminiferen-Fauna aus dem Helvetien des Jensberges südlich Biel (Kt. Bern).* Eclogae Geol. Helv., vol. 51, pp. 309–330, 22 text-figs.
Description of sixty-two foraminifera from eighteen samples from a section of marine sediments in the Molasse of northwestern Switzerland.

MARTINI, E.

*1958 – *Discoasteriden und verwandte Formen im NW-deutschen Eozän (Coccolithophorida).* Senckenbergiana Lethaea, vol. 39, pp. 353–388, 6 pls.
Revision of Eocene discoasterids recovered from 250 samples from wells and outcrops; description of thirty-one species and subspecies, of which thirteen are new.

MERTENS, E.

*1958*a* *Zur Kenntnis der Ordnung Ostracoda (Crustacea).* Geol. Jahrb., vol. 75, pp. 311–318, 11 pls.
The status of five suborders, eight superfamilies, forty-nine families, seventy-six subfamilies, and 822 genera is presented in eleven tables; important publications on the units above the rank of genus are listed.

1958*b* *Cythere lingenensis n. n. pro Cythere costata Mertens 1956.* Geol. Jahrb., vol. 75, p. 359.
New name because the first was an objective homonym.

MIELECKE, W.

1958 – *Über den "Septarienton" von Nennhausen bei Rathenow.* Zeitschr. Angew. Geol., vol. 4, pt. 8, pp. 366–373, 4 text-figs.
Reclassification of sediments found in clay pits as of Holstein interglacial age, on the basis of *Azolla filiculoides*.

MÜLLER, A. H.

1958 – *Lehrbuch der Paläozoologie; Vol. 2 – Invertebraten; Part. 1 – Protozoa-Mollusca.* 566 pp., 652 text-figs.
The first part of the second volume of the manual includes micropaleontology; seven orders of flagellates, thirty-five families of foraminifera, with the most important genera, four orders of Radiolaria, and some of the smaller groups of microfossils are reviewed and in part illustrated.

MÜLLER, K. J.

1958 – *Conodonten der oberdevonischen Independence- Schichten in Iowa.* Pal. Zeitschr., vol. 32, p. 9 (abstract).
Discussion of the stratigraphy, conodonts, and other fossils from Upper Devonian black shales.

MÜLLER, K. J., AND MÜLLER, E.

*1957 – *Early Upper Devonian (Independence) conodonts from Iowa; Part 1.* Jour. Pal., vol. 31, no. 6, pp. 1069–1108, 8 text-figs., 8 pls.
Detailed zonation by conodonts. Description of assemblages consisting of nine genera and thirty-four species, among which are two new genera and eight new species.

NEUY-STOLZ, G.

1958 – *Zur Flora der Niederrheinischen Bucht während der Hauptflözbildung unter besonderer Berücksichtigung der Pollen und Pilzreste in den hellen Schichten.* Fortschr. Geol. Rheinland Westf., vol. 2, pp. 503–526, 7 pls., 2 text-figs.
Illustrated description of the microscopic content of sections of the "light" and "dark" beds of the main seam of the Rhenish brown coal, including remains of fungi.

OSCHMANN, F.

1958 – *Erläuterungen zur Geologischen Karte von Bayern 1:25,000; Blatt Nr. 7038, Bad Abbach.* Bavaria, Geol. Landesamt, 2 text-figs., 3 pls., 5 enclosures.
Among other fossils foraminifera are used in mapping the Cenomanian and Turonian.

OVERBECK, F.

*1958 – *Pollenanalyse quartärer Bildungen.* In: FREUND, H., *Handbuch der Mikroskopie in der Technik.* Frankfurt a. M.: Vol. 2, pt. 3 (Mikropaläontologie), pp. 327–410, 13 text-figs., 6 pls.
Techniques, methods, and scientific principles of Quaternary pollen analysis are discussed in seven comprehensive chapters; different applications; general conditions; preparation of slides of Recent specimens for comparison; collection of samples in the field; eleven different treatment methods; interpretation and graphic representation of pollen counts; description, illustration, and discussion of 117 species.

PILGER, A., AND SCHÖNEBERG, R.
1958 – *Der erste Fund mitteltriadischer Tuffe in den Gailtaler Alpen (Kärnten).* Deutsch. Geol. Ges., Zeitschr., vol. 110, pp. 205–214, 3 text-figs., 3 pls.
Brief reference to conodonts, foraminifera, and calcareous algae; three thin sections of the latter are illustrated.

PFLUG, H. D.
1958 – *Anlage und Entwicklung der Niederrheinischen Bucht in der Oberkreide und im Alttertiär auf Grund sporenpaläontologischer Altersdatierungen.* Fortschr. Geol. Rheinland Westf., vol. 2, pp. 409–418, 2 text-figs.
Four lists of fossils and a brief discussion of problems arising in palynological analyses.

POTONIÉ, R.
1958*a* *Voraussetzungen einer Sporenstratigraphie der Steinkohlenlager.* In: FREUND, H., *Handbuch der Mikroskopie in der Technik.* Frankfurt a. M.: Vol. 2, pt. 3 (Mikropaläontologie), pp. 413–424, 2 pls., 1 text-fig.
Scientific principles, methods, and techniques in evaluating the stratigraphy of coal deposits by means of spores are indicated; nineteen isolated spores from the Carboniferous are figured.

*1958*b* *Synopsis der Gattungen der Sporae dispersae; II – Sporites (Nachträge), Saccites, Aletes, Praecolpates, Polyplicates, Monocolpates.* Geol. Jahrb., Beiheft no. 31, 114 pp., 11 pls.
Compilation, distinction, and synonymy of the genera of isolated mio- and megaspores published to date, including winged and non-winged pollen of gymnosperms; 141 figures.

RABIEN, A., AND RABITZ, A.
1958 – *Das Ober-Devon von Meschede.* Hessen, Landesamt Bodenf., Notizbl., vol. 86, pp. 159–184, 5 text-figs., 3 tables.
A section of about 250 meters, representing Devonian/Carboniferous transition, is subdivided mainly on the basis of ostracodes, of which twenty-five species were identified. Supplementary identifications of six conodont species by W. Ziegler. Discussion of similar ostracodes from China.

REIN, U.
1958 – *Quantitative Pollenanalyse an Lagerstätten tertiärer Braunkohlen.* In: FREUND, H., *Handbuch der Mikroskopie in der Technik.* Frankfurt a. M.: Vol. 2, pt. 3 (Mikropaläontologie), pp. 291–324, 11 text-figs.
Methods of collecting samples, and of isolation and microscopic study of Tertiary spores; special methods for the quantitative application of palynology in the detailed stratigraphy of the Rheinish brown coal; prospects and possibilities in deep mining, together with a standard diagram and examples of applications of palynology.

RICHTER, D.
1958 – *Zum geologischen Bau der Berge östlich des oberen Osterachtales (Allgäu); Der synsedimentäre Ursprung einer tektonischen Decke.* Deutsch. Geol. Ges., Zeitschr., vol. 109, pp. 519–549, 11 text-figs.
Brief mention of a few undifferentiated Cretaceous foraminifera (pp. 540–541).

RIETH, A.
1958 – *Vorkommen einer Foraminifere im Arterner Salzgebiet.* Mikrokosmos, vol. 47, pp. 100–105, 7 text-figs.
Photographs and dimensions of living foraminifera, probably *Jadammina* sp., in brackish inland waters.

SCHRIEL, W., AND STOPPEL, D.
1958 – *Das Alter der Hauptkieselschiefer Lossen's und der Buntschiefer in der Südharzmulde.* Deutsch. Geol. Ges., Zeitschr., vol. 109, pp. 559–565.
Reclassification of various Devonian beds on the basis of conodonts.

SCHÜNEMANN, H. W.
1958 – *Zur Stratigraphie und Tektonik des Tertiärs und Altpleistozäns am Südrand der Niederrheinischen Bucht.* Fortschr. Geol. Rheinland Westf., vol. 2, pp. 457–472, 9 text-figs., 1 table.
List of sporomorphs from brown coal beds on the southern margin of the Lower Rhine Basin.

SELLE, W.
1958 – *Das Interglazial von Neuenförde.* Geol. Jahrb., vol. 76, pp. 191–198, 1 pl., 2 text-figs., 1 table.
Fresh-water marl with a maximum thickness of 18 meters shows a hitherto unknown pollen diagram.

SIEVERTS-DORECK, H.
1958*a* *Echinodermen.* In: FREUND, H., *Handbuch der Mikroskopie in der Technik.* Frankfurt a. M.: Vol. 2, pt. 3 (Mikropaläontologie), pp. 239–264, 6 pls.
Data on the significance and application of microscopic echinoderm residues in stratigraphy, with 153 illustrations of Crinoidea, Ophiuroidea, Asteroidea, Echinoidea, and Holothuroidea.

*1958*b* *Über einige Comatulida aus Jura und Kreide.* Neues Jahrb. Geol. Pal., Abh., vol. 106, pp. 245–260, 1 pl., 2 text-figs.
Discussion of taxonomic questions, and description of two species from the Jurassic and Lower Cretaceous; *Solanocrinus lambertsi* and *S. janenschi* are new.

1958*c* *Kleinreste von Echinodermen aus dem fränkischen Jura.* Naturf. Ges. Bamberg, Ber., pp. 15–21.
Summary of Jurassic echinoderm remains, especially crinoids.

*1958*d* *Revision von "Apiocrinus" amalthei Quenstedt aus dem fränkischen Lias.* Neues Jahrb. Geol. Pal., Monatshefte, pp. 441–448, 5 text-figs.
A taxonomic revision shows that Quenstedt's species includes *Cyclocrinus amalthei* and *Eudesicrinus* n. sp.

SIMONSEN, R.

1958 – *Postglaziale Diatomeen aus Island.* Neues Jahrb. Geol. Pal., Monatshefte, pp. 25–32, 3 text-figs., 1 table.
Names of 109 diatoms from a 60-cm. section of Plio-Pleistocene peat, with conclusions regarding the climate.

SONNE, V.

1958 – *Obermitteloligozäne Ablagerungen im Küstensaum des nordwestlichen Mainzer Beckens.* Hessen, Landesamt Bodenf., Notizbl., vol. 86, pp. 281–315, 9 text-figs.
Thirty localities of "Schleichsand" occurrence, with lists of fossils, including eleven ostracodes and thirty-nine foraminifera.

STOPPEL, D., AND ZIEGLER, W.

1958 – *Zum Alter der "Buchenauer Schichten" bei Buchenau/Lahn (Rheinisches Schiefergebirge).* Hessen, Landesamt Bodenf., Notizbl., vol. 86, pp. 153–158, 1 text-fig.
Redating of the Buchenauer beds as upper Givetian by means of goniatites, trilobites, and conodonts.

TEICHMÜLLER, R.

1958 – *Die Niederrheinische Braunkohlenformation.* Fortschr. Geol. Rheinland Westf., vol. 2, pp. 721–750, 1 pl., 11 text-figs., 1 table.
Summary of the stratigraphy and paleogeography of the Lower Rhine brown coal. Brief note on foraminifera.

TEICHMÜLLER, M., AND THOMSON, P. W.

1958 – *Vergleichende mikroskopische und chemische Untersuchungen der wichtigsten Fazies-Typen im Hauptflöz der niederrheinischen Braunkohle.* Fortschr. Geol. Rheinland Westf., vol. 2, pp. 573–598, 3 text-figs., 4 pls., 5 tables.
Palynologic, petrographic, and quantitative chemical analyses and evaluation of sections permit discrimination of four types of facies in the main seam of the Lower Rhine brown coal.

THIERGART, F.

*1958 – *Die Sporomorphen-Flora von Rott im Siebengebirge.* Fortschr. Geol. Rheinland Westf., vol. 2, pp. 447–456, 1 pl.
Palynologic comparison of slab coals from the Siebengebirge with Lower Rhine brown coal, based on *Pityosporites podocarpoides*, n. sp.

THURSCH, H.

1958 – *Ein neues Verfahren zur Präparation von Kalkproben mit Essigsäure.* Neues Jahrb. Geol. Pal., Monatshefte, vol. 6, pp. 283–285.
If there is no monochloracetic acid available, it is recommended to use 10% acetic acid and to add HCl during the reaction, so that the pH remains constant at 3.

TRIEBEL, E.

1958*a* *Die Photographie im Dienste der Mikropaläontologie.* In: FREUND, H., *Handbuch der Mikroskopie in der Technik.* Frankfurt a. M.: Vol. 2, pt. 3 (Mikropaläontologie), pp. 85–114, 36 text-figs.
The optical basis, microphotographic equipment, and the technical proceedures are dealt with thoroughly. This is the first detailed representation of a proven technique that has been developed over many years. The difficult technique of azimuthal-illumination photography, and the achievement of considerable depths of field, are placed in the foreground.

*1958*b* *Ostracoden.* In: FREUND, H., *Handbuch der Mikroskopie in der Technik.* Frankfurt a. M.: Vol. 2, pt. 3 (Mikropaläontologie), pp. 193–236, 8 pls.
Diverse techniques for the examination of ostracodes, e.g., opening of closed shells, preparation of polished sections and oblique fractures, and investigation of Recent ostracodes, especially their appendages. Ecology, body structure, and morphology, with special description of features that are important in fossil specimens, such as impressions on the shell, eye tubercles, sculpture, sexual dimorphism, and the complicated details of the marginal area, the hinge, and the muscle scars. Classification of Meso- and Neozoic ostracodes.

*1958*c* *Zwei neue Ostracoden-Gattungen aus dem Lutet des Pariser Beckens.* Senckenbergiana Lethaea, vol. 39, pp. 105–117, 3 pls.
Detailed description and figures of *Urolebris*, n. gen., with *U. parnensis* (Apostolescu, 1955), and of *Idiocythere lutetiana*, n. gen., n. sp.

VALETON, I.

1958 – *Der Glaukonit und seine Begleitminerale aus dem Tertiär von Walsrode.* Hamburg, Geol. Staatsinst., Mitt., vol. 27, pp. 88–131, 2 pls., 14 text-figs.
In addition to the mineralogical research, W. Hinsch introduces a reclassification as Upper Oligocene of a 17-meter section, based on micropaleontological evidence. A few foraminifera are mentioned.

VOIGT, E.

*1958*a* *Bryozoen aus dem Kreidetuff von St. Symphorien bei Ciply (Ob. Maastrichtien)*. K. Belg. Inst. Nat., Meded., vol. 33, no. 43, pp. 1–48, 12 pls., 1 text-fig.
Names of 117 species from a new section of the type locality of the Maestrichtian are listed; they are evaluated with regard to zoogeography, ecology, and stratigraphy. Descriptions and illustrations of fourteen new species, *Onychocellaria*, n. gen., and *Virgocella*, n. gen.

*1958*b* *Untersuchungen an Oktokorallen aus der oberen Kreide*. Hamburg, Geol. Staatsinst., Mitt., vol. 27, pp. 5–49, 13 pls., 8 text-figs.
Identification and illustration of common coral fragments from washed residues. Description of seventeen forms, belonging to five genera.

WALLISER, O. H.

*1958 – *Rhombocorniculum comleyense n. gen. n. sp. (Incertae sedis, Unterkambrium, Shropshire)*. Pal. Zeitschr., vol. 32, pp. 176–180, 1 pl.
Description, photographs, thin sections, and chemical analysis of a problematical microfossil that consists mainly of fluorite and apatite.

WEILER, W.

1958*a* *Fischreste, insbesondere Otolithen*. In: FREUND, H., *Handbuch der Mikroskopie in der Technik*. Frankfurt a. M.: Vol. 2, pt. 3 (Mikropaläontologie), pp. 267–280, 12 text-figs.
Methods of identification of isolated bone remains, teeth, scales, and otoliths of fishes; special discussion of morphology.

1958*b* *Fisch-Otolithen aus dem Oberoligozän und Mittelmiozän der Niederrheinischen Bucht*. Fortschr. Geol. Rheinland Westf., vol. 1, pp. 323–362, 3 pls., 12 text-figs., 2 tables.
Descriptions of otoliths of fifty-three fish species from the littoral, infraneritic, and abyssal zones. They are accumulated as thanatocoenoses as is usual in deposits of the Tertiary North Sea.

WETZEL, O.

1958 – *Neue Mikrofossilien aus dem Lias, insbesondere aus dem Posidonienschiefer*. Pal. Zeitschr., vol. 32, p. 15 (abstract).
Discussion of problematic microfossils, especially from the Jurassic.

WIENHOLZ, E.

1958 – *Über die Gliederung des Alttertiärs im westlichen Mecklenburg*. Geol. Ges. D.D.R., Ber., vol. 3, pp. 90–98, 6 pls., 2 text-figs.
The marine Lower Tertiary, which is up to 680 meters thick in test wells on four structures in western Mecklenburg, is classified on the basis of microfaunas. Photographs of six characteristic foraminiferal faunas, and figures of four electric well logs.

ABSTRACT: Globotruncana ventricosa ventricosa *is recorded from core samples of Maestrichtian age in the Sechura Desert of northwestern Peru. Location map and illustrations are included.*

Occurrence of Globotruncana ventricosa in northwestern Peru

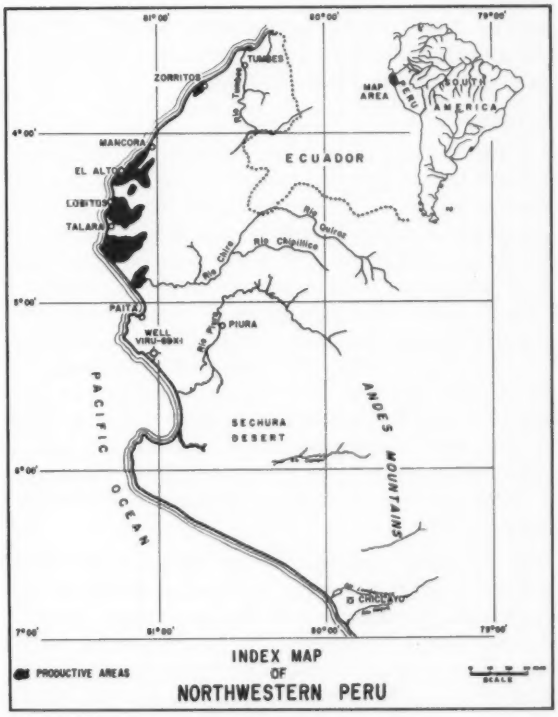
EDWIN T. ASHWORTH
International Petroleum Company, Ltd.
Talara, Peru

INTRODUCTION

Between 1953 and 1956, the International Petroleum Company, Ltd., drilled a number of exploratory wells in the Sechura Desert of northwestern Peru. During the drilling of one of these wells, Viru 69–X–1, located along the coast in the northwestern sector of the Sechura Desert (text-fig. 1), numerous specimens of *Globotruncana ventricosa ventricosa* White were observed in several cored intervals.

Although Weiss (1955) reported the presence of three subspecies of *Globotruncana lapparenti* Brotzen in his paper on the planktonic foraminifera of northwestern Peru, this is the first record of *Globotruncana ventricosa ventricosa* in Peru. This species has been recorded in the Caribbean area previously from Mexico, Colombia, and Trinidad, and the Peruvian occurrence thus extends its geographic range southward. Also of interest is its appearance in beds of Maestrichtian age, well confirmed by its faunal associations, which adds to its significance as a valid Campanian-Maestrichtian marker in the Caribbean province.

This paper is published with the kind permission of the management of the International Petroleum Company, Ltd. Grateful thanks are also due to Lawrence Weiss for his suggestions and criticisms, and to Manuel Alban for the camera-lucida drawings.



TEXT-FIGURE 1

GEOGRAPHIC DISTRIBUTION AND RANGE

Globotruncana ventricosa ventricosa White has been reported from various parts of the world, its stratigraphic range differing between continents and with authors. Dalbiez (1955) listed its approximate range in Tunisia as lower Santonian although in the European section it appears to be best known from the Coniacian to the Campanian. In the Gulf Coast region of the United States, Cushman (1946) recorded it from the Coniacian to the upper Santonian. In Mexico, White (1928*b*) described *Globo-*

TEXT-FIGURE 2

Globotruncana ventricosa ventricosa White, from Maestrichtian shale in well cores of the International Petroleum Company's well Viru 69–X–1, Sechura Desert of northwestern Peru: a–c, dorsal, ventral, and peripheral views; all × 72.

truncana ventricosa chiefly from the upper Pagapallos (now regarded as Mendez), of Campanian to Maestrichtian age. Bolli (1951) indicated that it was restricted in Trinidad primarily to the Maestrichtian, and Gondolfi (1955) listed its range in Colombia as Campanian to Maestrichtian.

OCCURRENCE

On the basis of this first record, it is not possible to delimit the stratigraphic range nor to draw definite conclusions as to the stratigraphic development of the genus in Peru. No other species of *Globotruncana* were observed in the well in which the specimens of *Globotruncana ventricosa ventricosa* were found, and previously only three subspecies of *Globotruncana lapparenti* Brotzen were known from the Peruvian Cretaceous (Weiss, 1955). However, it is perhaps significant with regard to evolutionary development that the *Globotruncana lapparenti* subspecies occur in beds of Turonian to Campanian age, and that the faunal assemblages of the Viru 69–X–1 well cores indicate a Maestrichtian age for *Globotruncana ventricosa ventricosa.*

The Maestrichtian age of the Viru 69–X–1 well cores is confirmed by the presence of *Flabellammina colombiana* (Cushman and Hedberg) and *Rugoglobigerina rugosa* (Plummer), both considered to be index foraminifera for the Maestrichtian stage in the Caribbean. Also present are *Siphogenerinoides parva* Cushman, a Maestrichtian marker in northwestern Peru, and *Siphogenerinoides bramletti* Cushman of Campanian to Maestrichtian range in Peru but a good Maestrichtian indicator in Colombia. In the core material, *Globotruncana ventricosa ventricosa* occurs in common numbers, associated with *Siphogenerinoides bramletti*, *Globigerina cretacea* d'Orbigny, *Gembelina globulosa* (Ehrenberg), *Rugoglobigerina rugosa*, and *Flabellammina colombiana.*

SYSTEMATIC DESCRIPTION

Order FORAMINIFERA

Genus GLOBOTRUNCANA Cushman, 1927

Subgenus GLOBOTRUNCANA Cushman, 1927

Globotruncana (Globotruncana) ventricosa ventricosa White
Text-figure 2a–c

Globotruncana canaliculate (Reuss) var. *ventricosa* WHITE, 1928, Jour. Pal., vol. 2, no. 4, p. 284, pl. 38, fig. 5a–c.
Globotruncana ventricosa White. – CUSHMAN, 1946, U. S. Geol. Survey, Prof. Paper no. 206, p. 150, pl. 62, fig. 3a–c.
Globotruncana ventricosa ventricosa White. – DALBIEZ, 1955, Micropaleontology, vol. 1, no. 2, p. 168, text-fig. 7a–d.

Test characterized by a flat to very slightly concave dorsal side, a strongly convex ventral side, and a distinct, roughly parallel double keel. Particulary noteworthy in the Peruvian specimens are the increasingly larger, strongly globular chambers.

Occurrence in Peru: Maestrichtian shale section, in well cores of the International Petroleum Company's well Viru 69–X–1, in the Sechura Desert of northwestern Peru.

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1951 – *The genus Globotruncana in Trinidad, B.W.I.* Jour. Pal., vol. 25, no. 2, pp. 187–200, pls. 34–35, text-fig. 1, tables 1–2.

BRONNIMANN, P.
1952 – *Globigerinidae from the Upper Cretaceous (Cenomanian-Maestrichtian) of Trinidad, B.W.I.* Bull. Amer. Pal., vol. 34, no. 140, pp. 1–61, pls. 1–4, text-figs. 1–30.

CUSHMAN, J. A.
1946 – *Upper Cretaceous foraminifera of the Gulf Coastal region of the United States and adjacent areas.* U. S. Geol. Survey, Prof. Paper no. 206, pp. 1–160, pls. 1–66, 1 table.

DALBIEZ, F.
1955 – *The genus Globotruncana in Tunisia.* Micropaleontology, vol. 1, no. 2, pp. 161–171, text-figs. 1–10, charts 1–2.

EDGELL, H. S.
1957 – *The genus Globotruncana in northwestern Australia.* Micropaleontology, vol. 3, no. 2, pp. 101–126, pls. 1–4, text-figs. 1–4, table 1.

GANDOLFI, R.
1955 – *The genus Globotruncana in northeastern Colombia.* Bull. Amer. Pal., vol. 36, no. 155, pp. 1–118, pls. 1–8, text-figs. 1–12.

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HAMILTON, E. L.
1953 – *Upper Cretaceous, Tertiary and Recent planktonic foraminifera from mid-Pacific flat-topped seamounts.* Jour. Pal., vol. 27, no. 2, pp. 204–237, pls. 29–32, text-figs. 1–5, table 1.

PETTERS, V.
1955 – *Development of Upper Cretaceous foraminiferal faunas in Colombia.* Jour. Pal., vol. 29, no. 2, pp. 212–225, text-figs. 1–7.

WEISS, L.
1955 – *Planktonic index foraminifera of northwestern Peru.* Micropaleontology, vol. 1, no. 4, pp. 301–319, pls. 1–3, text-fig. 1, tables 1–2, 1 chart.

WHITE, M. P.
1928*a* – *Some index foraminifera of the Tampico Embayment area of Mexico; Part. 1.* Jour. Pal., vol. 2, no. 3, pp. 177–215, pls. 27–39.

1928*b* – *Some index foraminifera of the Tampico Embayment area of Mexico; Part. 2.* Jour. Pal., vol. 2, no. 4, pp. 280–317, pls. 38–42.

Reviews

VLADIMÍR POKORNÝ: *Grundzüge der zoologischen Mikropaleontologie*, Volume 2, 453 pages, 528 figures, 8 vo., bound. Published by VEB Deutscher Verlag der Wissenschaften, Berlin, 1959. Price: DM 48.

At last there is a textbook on Ostracoda! This is the second volume of a basis textbook of micropaleontology; the first volume dealt with the Protozoa. Volume 2, covers more than Ostracoda, however, as there are chapters on Octocorallia, Scolecodonta, Conodonts, Echinodermata, Ascidiacea and Otoliths, all of which should be of interest to those working with fossil ostracoda. The main portion of the volume, pages 66–322, deals with the Ostracoda, and there is a very extensive ostracod bibliography, pages 375–402, which is broken down into such fields as bibliographies, morphology, ecology, taxonomy, and the faunas of each of the major subdivisions of the geologic column. The work is very complete, with ample discussion of the anatomy, the morphology of the carapace, the details and terminology of the parts of the valves, the ecology of ostracoda, and their classification. Pokorný considers the Ostracoda as a subclass, divided into the Orders Leperditiida, Beyrichiida, Podocopida, and Myodocopida. In the handling of the suborders, families and genera, Pokorny has been conservative and has introduced only a few new terms. In a field such as the Ostracoda, where classificatory terminology has multiplied with such rapidity, no author could satisfy everyone to the minutest detail. Pokorný, however, has done a masterly job of making order out of the extreme complexities which have developed in recent years. This work is apparently up to date through 1956, and most genera used by paleontologists are included. Over 400 superb illustrations are devoted to these genera; in most cases each illustration consists of a number of figures. At the close of the ostracod chapter there is a glossary of essential morphological terms given in German, English, French and transliterated Russian.

One cannot but marvel at the immense amount of work that has gone into this superb volume. The care and detail involved in its preparation may best be illustrated by the fact that following the complete bibliographies for each of the chapters, there is an index giving page references for each of the terms used in description. This is followed by an additional index to all of the taxonomic terms used. Finally at the end of the volume there is an index to the authors whose works have been cited. It is fitting that this fine work appeared on the 200th anniversary of the beginning of ostracod study. It is so complete and so superbly prepared that it should be in the hands of all ostracod workers.

HENRY V. HOWE

School of Geology
Louisiana State University
Baton Rouge, Louisiana

PALAEONTOLOGY, Volume 1, Parts 1–4. Published by the Palaeontological Association, London. Annual subscription and membership, £ 2. 2s. ($6.25); individual parts £ 1. 15s. ($5.20).

The Palaeontological Association has initiated a new and imposing publication, known as PALAEONTOLOGY, devoted to the study of fossils. The initial volume of this publication consists of four parts issued between November 1957 and January 1959. This journal, which deals with all aspects of paleontology and stratigraphic paleontology, is to be issued twice yearly. The initial volume contains thirty-eight articles, two of which deal with general paleontology, three with vertebrate paleontology, twenty-two with invertebrate paleontology (exclusive of micropaleontology), eight with micropaleontology, and three with paleobotany. The articles range in content from the redefinition of genera and stratigraphic occurrences to a discussion of the locomotion of a saurian.

The new journal, which is Crown Quarto in size, is well designed and amply illustrated. Subscriptions and membership in the Palaeontological Association can be secured through Dr. W. S. McKerrow, Treasurer of the Association, who is located at the Department of Geology and Mineralogy, University Museum, Oxford, England.

RICHARD CHARMATZ

Department of Micropaleontology
The American Museum of Natural History
New York

V. Standish Mallory: *Lower Tertiary Biostratigraphy of the California Coast Ranges.* Published by the American Association of Petroleum Geologists, Tulsa, Oklahoma, 416 pages, 42 plates, 7 text-figures, 19 tables, 1959. Price: $11.00 to members of the Association, $12.00 to non-members.

As a result of some three years of intensive field work, two comprehensive squences of foraminiferal samples were collected from Lower Tertiary strata exposed along the west side of the San Joaquin Valley in western California. Subsequent field and laboratory work, together with an exhaustive search of the literature, have enabled the author to establish a detailed standard chronologic-biostratigraphic section for the Lower Tertiary of California. In addition, Dr. Mallory has provided an up-to-date checklist of the significant foraminifera recorded from western California. The chronological-biostratigraphic section and the checklist are, in themselves, valuable contributions. However, the author has gone a step further and synthesized his voluminous data to show correlations within the California province and with other North American and European sections.

A major part of this work consists of a systematic catalogue of all the foraminifera, either collected or discussed by the author, including some fifty-four new species and varieties. The foraminifera contained in the systematic section are illustrated on forty-two plates. In addition, a register of localities provides details of the stratigraphy of the samples as well for the foraminifera in the checklists.

Dr. Mallory is to be congratulated on this significant and useful publication which is highly recommended to all students of biostratigraphy and the foraminifera.

Caroline A. Turco
Department of Micropaleontology
The American Museum of Natural History
New York

Hugo Freund (Editor): *Handbuch der Mikroskopie in der Technik;* Volume 2, *Mikroskopie der Bodenschätze,* Part. 3, *Mikroskopie in der Geologie Sedimentärer Lagerstätten (Mikropaläontologie).* Published by Umschau Verlag, Frankfurt am Main, 450 pages, 160 photomicrographs, 3 tables, 36 text-figures, 1958. Price: DM 115.—

This excellent publication published by Umschau Verlag is a symposium edited by Dr. Hugo Freund. The introduction, in which the practical application of micropaleontology is stressed, was written by Dr. Alfred Bentz and Dr. Freund. An historical account of the early recognition and use of microfossils is by Dr. Heinrich Hiltermann who also discusses the application of micropaleontology in the petroleum industry. Various methods of preparation and study are discussed. There is a detailed account of the preparations of thin sections and the various systems of storing samples. Dr. Helmut Bartenstein has written on the ever increasing significance of the practical application of micropaleontology in the petroleum industry.

There is an account, by Dr. Erich Triebel, of the use of photography in micropaleontology. This section of the symposium starts with a discussion of theoretical optics and is followed by an account of photomicrographic equipment and its use. Particular attention is paid to methods of exposure, depth of focus and the preparation of microfossils for photomicrography. The special problems of preparing Paleozoic microfossil material are discussed at some length by Dr. Heinz Beckmann.

In the section devoted to various microfossil groups, Dr. Heinrich Hiltermann has covered the foraminifera, Dr. Erich Triebel the ostracoda, and Dr. Hertha Doreck, echinoderm fragments. Scales, otoliths, teeth, and other fragmental fish remains are covered by Dr. Wilhelm Weiler, and the charophyta by Karl Mädler. Quantitative analyses of Tertiary pollen have been covered by Dr. Ulrich Rein, and the Quarternary spores and pollen by Dr. Fritz Overbeck.

There is a section on the stratigraphy of coal beds based on spores by Dr. Robert Potonié and an important section on diatoms by Dr. F. Hustedt.

This symposium, written by the leaders in micropaleontology in Germany, is an excellent source book. It is well written and illustrated, and is recommended to all persons working with microfossils.

Hans J. Behm
New York University
New York

news reports

FRANCE

JEAN CUVILLIER

Institut Français du Pétrole

The work of the various laboratories of micropaleontology has been concerned especially with the stratigraphic problems of the new Paleozoic oilfields in the Sahara. During months and at present, the Palynological Service, under the direction of B. de Jekhowsky, has been making statistical analyses of the distribution of hystrichospherids, which furnish good correlations within the Ordovician; the Chitinozoa, studied by Ph. Taugourdeau, show faunizones in the Siluro-Devonian (Soc. Géol. France, C. R. Somm., no. 1, January, 1959).

In the conodont laboratory, M. Lys and Mrs. B. Serre are continuing their systematic studies of the Paleozoic in France (Morvan, Anjou, Avesnois), in Belgium (Hainaut), and in Spain (Asturia) (Inst. Franç. Pétrole, Rev., vol. 13, no. 6, June, 1958). These studies, together with the establishment of a complete species card-index of conodonts, are being carrid on together with the study of the foraminifera of the same regions and levels. Studies on the foraminifera of the Jurassic, Cretaceous, and Tertiary formations of Spain (Ebro and Guadalquivir) and of Madagascar (Majunga) are being made by J. Sigal in collaboration with M. Lys.

In the ostracode laboratory, N. Grekoff has done a large amount of work on samples from the continental Cretaceous of the Belgian Congo and on material from France and Madagascar. G. Deroo is continuing his study of the Ostracoda of the Maestrichtian of the type locality. V. Apostolescu is publishing a paper on the Liassic Ostracoda of the Basin (Inst. Franç. Pétroles, Rev).

A publication by J. Lantz (Rev. Micropaléontologie, 1958, and Inst. Franç, Pétrole, Rev. June, 1958), and another by B. de Jekhowsky on techniques of treating rocks for the extraction of microfossils (Inst. Franç. Pétroles, Rev., October, 1958, and Bull. Serv. Inf. B.R.G.G. M., Paris, 1959) are noteworthy.

University of Paris

The laboratory of Micropaleontology, again with forty first-year students being prepared for the "Certificat de Micropaléontologie," also has fifteen second-year students whose research work is in preparation for theses in the various branches of micropaleontology. Teaching consisting of six lectures a week and three laboratory sessions, is conducted by Professor J. Cuvillier, Mrs. M. Neumann, and D. Boulanger; in addition, special courses on Ostracoda and in palynology, sedimentary petrology and other subjects are given by MM. Grekoff, Alpern and Lezaud. In October, 1958, Miss J. Lantz was appointed assistant; in the near future, she will take charge of the section of palynology. The collections of the department have been enlarged by samples of all sorts received from Italy, North and Central Africa, the Middle East, and elsewhere.

In June, 1958, Miss Rouvillois presented her theses, entitled "Le Thanétien du Bassin de Paris; étude hydrogéologique et micropaléontologique." This important work, with field sections, description of numerous foraminifera, Ostracoda, and algae, is illustrated with eight plates.

A large part of the activities of the of the department have dealt with the preparation of the "Revue de Micropaléontologie," which is now in its second year. The four numbers of Volume 1 contain twenty-five contributions on various aspects of micropaleontology. The periodical is under the direction of Professor Cuvillier, with Mrs. M. Neumann being responsible for the editing and M. D. Boulanger acting as treasurer. The publication of the "Revue de Micropaleontologie" was accomplished with the substantial help of many oil research companies and the numerous subscriptions of our readers. Mrs. Le Blanc has taken a large part in the organization and distribution of the Revue.

Miss Aurouza (now Mrs. Bizon) has left the laboratory. She has been replaced by Mrs. Potiron. A large number of French and foreign micropaleontologists visited the department during 1958, some of them spending several weeks with our collections. The micropaleontology laboratory (collections, workers, and teaching) will soon be transferred to a new building, with the same address, but separated from the Department of Applied Geology.

École Pratique des Hautes Études

During 1958, the Laboratory of Micropaleontology left the Annex of the Faculté des Sciences, where it had been since 1943, and moved to the Museum. This temporary installation, obtained by the courtesy of Professor J. P. Lehman, Head of the Paleontology Department of the Museum, is to be followed by a final transfer to a building belonging to the same service. This should allow the laboratory to be reorganized and enlarged in the near future.

On the occasion of the International Congress of Zoology, held at London, Professor G. Deflandre and Mme. M. Deflandre-Rigaud expressed their opinions on the problem of parataxonomy. A paper entitled "Apropos de l'introduction des parataxons dans la nomenclature zoologique" (Bull. Zool. Nomencl., London, vol. 15, April, 1958, pt. 22, Document I/55, pp. 705–724) recalls the proposal by the authors at the 18th International Congress of Zoology, held at Paris in 1948, to introduce a morphological system of terminology into zoological nomenclature, and that their proposal was rejected by the Commission. They also point out the priority of C. Croneis's "Ordo militaris" over any other terminology to be used in parataxonomy. Specific applications of parataxonomy to living and fossil Protista (Protozoa and Protophyta), to microfossils incertae sedis, and to fragments of Metazoa are cited. In London, the congress, including both neontologists and paleontologists, could not reach an agreement on the practical application of parataxonomy, and the question was left to be considered again to another congress.

The Tenth Series of the "Fichier Micropaléontologique" was published by G. Deflandre et Mme. M. Deflandre-Rigaud. This series, entitled Hystrichosphaeridés IV et Genres incertae sedis; espèces du Secondaire et du Tertaire, Supplément I" (Arch. Orig. Centr. Docum. C.N.R.S., no. 366, 1958), contains 480 cards reproducing the illustrations of all previously known and new species published from 1946 to 1957, and also giving an index, the geologic range, and bibliography of each species. Series 1 to 9 of this "Fichier" (published 1943–1949) cover the Chrysomonadina, Dinoflagellata, Hystrichospheres, Radiolaria (of the Paleozoic), Chitinozoa, and Ciliata. The "Fichier Micropaléontologique" is distributed by the Centre de Documentation du C.N.R.S. (positive standard film or facsimile 12 × 20 cm.), the orders being sent to the Laboratory.

Mme. M. Deflandre-Rigaud is again working on holothurian sclerites of the Oxfordian. Jean Deunff presented a paper on new species of hystrichospherids from the Ordovician of Brittany. L. Valensi is continuing his research on Cretaceous flints. He has published a paper entitled "Micropaléontologie des silex du Grand Pressigny" Soc. Geol. France, Bull., ser. 6, vol. 7 (1957), issued July, 1958). L. Decloitre has completed three papers on the thecamoebians, one of which, "Thécamoebiens récoltés au Cameroun par A. Villiers," has been published (Inst. Franç. d'Afrique Noire, Bull., vol. 20–A, pp. 1139–1144, 1958). Many French and foreign research workers visited the laboratory before it moved, among whom was Dr. W. S. Hoffmeister of the Jersey Production Research Company. Mme Y. Le Calvez, of the B.R.G.G.M., also visited the summer laboratory at Forcalquier, being interested in the methods of work and research used for very small microfossils such as coccolithopharids.

Bureau de Recherches Géologiques, Géophysiques et Minières

In addition to routine work on the stratigraphy of the Paris Basin, the activities of the laboratory have dealt with the study of the Mio-Pliocene of Normandy and the Alpes-Maritimes, the Upper Cretaceous reef-facies of the Gard and Bouches-du-Rhône, and the tectonics of the Haute-Marne. These studies have revealed the existence of several new genera, *Goupillaudina*, *Sornayina*, *Vandenbroekia*, and have given rise to the following papers by P. Marie: "Présence d'un fossé de subsidence dans le prolongement Argonnais de la double faille de la Marne" (Soc. Géol. France, Bull., ser. 6, vol. 7 (1957–1958), pp. 229–237) (in collaboration with M. Clin); "Contribution à l'etude de la microfauna des marnes plaisanciennes des Alpes-Maritimes" (ibid., pp. 767–774) (in collaboration with M. J. Perriaux); "*Goupillaudina*, noveau genre de foraminifère du Crétacé superieur" (ibid., pp. 861–876, 1 pl.); "Sur la faune de foraminifères des marnes à *Nassa* du Bosq d'Aubigny" (Congrès Soc. Savantes, 83, C.R., "Miocene," 1958, pp. 239–246); and "Peneroplidae du Crétacé supérieur à faciès récifal; à propos des genres *Broekina* et *Praesorites* et sur le nouveau genre *Vandenbroekia*" (Rev. Micropaléontologie, vol. 1, fasc. 3, 1958, pp. 125–139, 1 pl.).

Mrs. Le Calvez is continuing her research work on the Tertiary of the Paris Basin. During the past year, the laboratory was visited for varying periods by Mme. Nazemi (microfaunas of Iran), M. Goel (microfaunas of the Cretaceous of the Rouen district), and Mrs. Tronchet (Callovo-Oxfordian of the Doubs).

Compagnie Française des Pétroles

The staff of the laboratory of sedimentology in Paris includes four geologists: G. Nouer, the head; R. Lacassagne, his assistant, who deals especially with microfacies, matters of sedimentary petrography, correlations, general interpretation, and direction of methods; and Mademoiselle H. Garrot and Madame G. Authier, who study foraminiferal and ostracode microfaunas in particular. During 1958, activities were concerned with the following topics:

Paris Basin: Routine work on the Jurassic encountered by the drilling rigs of the C.F.P. (Normandie) was continued. It permitted a detailed sedimentary study and correlations by microfacies and microfaunas, which an attempt will be made to correlate with the other parts of the Basin. With regard to the Foraminifera and Ostracoda of the Lias, sketches have been prepared for the whole Basin. A survey of the Dogger of the Ardennes has been made and correlations extended to the wells of the C.F.P.

Southeastern France: The study of this area began in 1957. With regard to the Jurassic and Lower Cretaceous in outcrops and in wells of various companies, it has been completed. Many lateral variations in facies were found between the edges and the center of the Basin. The old concept of a "deep zone" applied to the Barronies country appears to be wrong, on the basis of sedimentary findings. Paleogeographic maps of various Jurassic and Lower Cretaceous series have been made.

Tertiary of Northern Spain: Detailed work on several Paleocene and Eocene field sections by microfacies and microfaunas (foraminifera) has made it possible to establish correlation, to observe stratigraphic breaks, and to work out the paleogeography of this region. The microfauna found there is rich and includes benthinic forms such as *Discocyclina seunesi*, *Opertorbitolites douvillei*, *Alveolina elongata*, *Fabiania*, and *Nummulites*.

Paleozoic of Guinea: This study, which dealt especially with the Cambrian, Ordovician and Silurian, covered only sequences of sandstones or silty clays, nearly all of which are unfossiliferous. It was therefore necessary to investigate these rocks from the point of view of petrographic and granulometric character. During 1958, G. Nouet published a paper (Rev. micropaléontologie, no. 1).

Mobil Oil Française

MOBIL-REPGA laboratory work started in Bordeaux in 1957, with Miss Poupon working on the micropaleontological and stratigraphic problems of the area. In 1958, the laboratory of the Production Department in Paris was opened, with Miss Cousin working on paleontological problems of the Paris Basin, with special emphasis on the Dogger and the Lias. Mr. Glazewski supervises both laboratories.

Companie d'Exploration Pétrolière

The Company's exploration activities during 1958 were focused mainly on the Paleozoic of the Sahara Concessions Reggane and Tinrhert basins), where satisfactory correlations were obtained by means of foraminifera, ostracodes, and conodonts. Zonation of the Cretaceous-Jurassic sequence in the Paris basin was established. H. Oertli published a paper on the ostracode fauna of the Aptian of Apt (Inst. Franç. Pétrole, Rev., vol. 13, no. 11, 1958), a note on a new Upper Jurassic ostracode genus, *Vernoniella* (Rev. de Micropal., vol. 1, no. 3, 1958), and, in collaboration with Mr. Ziegler, of Zürich, an article on a lacustrine horizon in the Sequanian of the Pontarlier area (Eclogae Geol. Helv., vol. 51, no. 2). His monograph on the Upper Jurassic ostracode faunas of the Swiss Jura Mountains is now in press. Some new genera and species from the upper Bathonian and lower Oxfordian of France and Switzerland are being studied. Mr. Grosdidier has nearly finished a study of the Lower Cretaceous of the Paris basin. Wolf Maync revised the foraminiferal faunas of the Devonian-Carboniferous section encountered in the Company's Sahara Concessions, and also began a study of the Lower Cretaceous sequence of southern France. A note on the genera *Alveolophragmium* and *Reticulophragmium* was published (Eclogae. Geol. Helv., vol. 51, no. 2), and another paper dealing with *Spirocyclina* and *Iberina* (Micropaleontology, vol. 5, no. 1). Other publications are still in press, one on two new Cretaceous species of *Pseudocyclammina*, another on the new lituolid genus *Martiguesia*, and still another on the new genus *Torinosuella*. Some interesting Middle and Lower Jurassic material from France, Italy, Switzerland, and Yugoslavia, which contains larger foraminifera (*Orbitopsella*, *Orbitammina*, etc.), is being studied, as well as the little-known genus *Yaberinella*, from the Eocene of Jamaica.

University of Dijon

Under the direction of Professor R. Ciry, dean of the Faculty of Science, various work was carried on in the Laboratory of Geology. P. Rat is preparing a detailed study of the microfacies of the Bajocian in Burgundy. In his thesis, entitled "Le Nummulitique sud-pyrénéen à l'Ouest de l'Aragon," J. P. Mangin presented (Dec. 2, 1958) the result of seven years of detailed field and laboratory research. His paper (657 pp., 111 figs., maps, logs, and range charts) is in press (preprints are in the library at Dijon and of the Société Géologique de France). From the point of view of micropaleontology, Mangin has constructed a detailed stratigraphic chart of the Paleogene in a large area of the Pyrenees, based only on foraminiferal assamblages and microfacies. The successions of biofacies and lithofacies are indicated and discussed, especially near the Cretaceous Tertiary boundary. Other brief papers have also been published (C. R. Acad. Sci,, vol. 246, pp. 1234–1237; 3479–3481; 3652–3654).

Mrs. M. Mangin is progressing in her general study of the Miliolidae. In collaboration with M. Sigal, of the Institut Français du Pétrole, she has examined the first part of the Schlumberger collection, and with the authorisation of the Muséum d'Histoire Naturelle de Paris, the Terquem collection as well. All topotypes of Miliolidae will be accepted with gratitude.

Various "Diplômes d'Études Superieures" were presented, some of which are of especial interest: On microfacies of the Bajocian, by MM. G. Magniez and E. Vernus; on foraminifera of the Albian of the Côte d'Or, by Mrs. R. Nicolas; on the Eocene planktonic foraminifera of Spain and the Aquitaine Basin, by Miss S. Novat, Miss M. Malapris, and Miss J. Lambert; and on "microforaminifera" of the Italian Pliocene, by Mrs. F. Tixier.

Société de Recherches Petrolières dans la Région Parisienne

The stratigraphic laboratory has directed its research work mainly toward detailed study of the lithologic and micropaleontological characteristics of the Dogger, which is the productive reservoir of the area.

Société Esso de Recherches et d'Exploitations Pétrolières

Most of the paleontological work during 1958 was devoted to routine studies of the exploration and devel-

opment wells of our Bordeaux permit, mainly on Cretaceous prospects. Wells of other companies and several field sections in the Pyrenees were also studied in order to acquire a better knowledge of the stratigraphy of southern Aquitaine before drilling in our new southern permits.

Mr. J. Magné, formerly Chief of the Geological Laboratory of S. N. REPAL in Algiers, joined ESSO REP as head of the paleontological section in January, 1959. He replaces Mr. F. Dalbiez, who has been acting Chief Geologist since December, 1957. C. Gaudin is working on the Jurassic-Cretaceous transition beds in northern Aquitaine. G. Malmoustier has compled his work on the Oligo-Miocene microfauna of St-Geours-de-Maremne, Landes, which will be presented for a "Diplôme d'Études Supérieures" at Bordeaux University. He attended the European micropaleontological meeting in September, which was held in Italy.

A short papers on the age of the Carcans dolomite was recently published by F. Dalbiez and R. M. Seronie-Vivien (Soc. Geol. France, C. R. Somm., no. 1, 1959, pp. 11–12). G. Dubar, of the Catholic University of Lille, collaborated with them in this work.

Compagnie Française des Pétroles (Gascogne)

Miss P. Fernet and Miss O. Sourdillon, working maily on free microfaunas, heve been assisting Mr. Ph. Dufaure. During 1958, the laboratory's activities were concerned principally with stratigraphic work in new field sections and wildcat logs.

Field activities in the Jurassic were restricted to stratigraphic problems of the Triassic-Lower Lias in the western Pyrenees, near Saint-Jean-Pied-de-Port. The "Muschelkalk" appears to be not well characterized from the paleontologic and micropaleontologic points of view. It is impossible to distinguish microfacies of the so-called "Muschelkalk" from Lower Lias microfacies dated as Rhaetic or Hettangian, such as oolitic and destrital limestones with *Frondicularia*.

The north-south contact line between the provinces of the Middle and the Upper Jurassic was traced by recent drilling in northern Aquitaine (Ph. Dufaure: "Contribution à l'étude stratigraphique et micropaléontologique du Jurassique moyen et supérieur, de l'Aquitaine à la Provence," Rev. de Micropal., vol. 1, face. 2, pp. 87–115). The transition zone appears to be very narrow. In the northern part of the Aquitaine basin, a useful ostracode sequence has been established in the Upper Jurassic, especially the Kimeridgian.

The distribution of biostrome and bioherm facies of the Cretaceous has been studied in Aptian and Albian limestones, marly limestones, and shales exposed along the northern Pyrenees from south of Bayonne to the upper Garonne Valley. The Upper Cretaceous, especially the lower part, was investigated in a region extending from south of Oloron to south of Montrejeau. Throughout a uniform sequence in the Flysch belt, paroxysmal basement movements took place in the Cenomanian, in the upper part of the Turonian, and in the lower Senonian (Coniacian?). In calcareous sequences of the northern Aquitaine platform, indications of minor movement are found in the lower Cenomanian, at the top of the Cenomanian and top of the Turonian, and in the lower Senonian.

Société Nationale des Pétroles d'Aquitaine

During 1958, the Pau laboratory was staffed by the following geologists: M. Delmas, J. Marot, M. Rey, Mrs. Aubert, and Mrs. G. Marot, and, from July on, R. Elloy for petrography. Activities dealt mainly with the study of numerous samples from wells (about sixty) and field geology. The latter studies were carried on chiefly in the region of "Ossum–Montgaillard–Bagnères–Lourdes." Difficulty was encountered regarding the Albian-Cenomania boundary, where microfaunas are very scarce or not characteristic. Some Upper Cretaceous microfaunas were recovered; several marly levels interbedded in breccias yielded faunas which may be reworked, although they appear to be perfectly preserved.

As a result of the large number of routine samples, only a few search projects were undertaken, among which was a study of Lower Cretaceous foraminifera by M. Rey and Mrs. J. Aubert, in which M. Rey demonstrated the existence of the Lacq reef. This "bioherm," of transgressive type, seems to have grown from the middle Aptian to the upper Albian. J. Marot continued to study Lower Cretaceous and Upper Jurassic Ostracoda.

During 1958, the stratigraphic laboratory at Montelimar, directed by J. Faber with J. Maillard and Miss F. Leduc as assistants, carried on general studies on the Lias, Neocomian, and Upper Cretaceous, in addition routine-work on material from surveys and drilling. Miss Leduc studied microfacies from the Lias and Dogger of the Massif Central border. Marker horizons were recognized in the Hettangian (limestones with coprolites and colitic limestones) and in the lower middle Lias (limestone with *Involutina liasina*). J. Maillard completed his study of the Upper Cretaceous of the Dieulefit basin and its borders. A correlation table showing variations between the different sections was established. J. Faber continued studying Neocomian and Barremian samples from Ardèche. The Neocomian sequences are very thick and uniform; numerous samples had to be studied in order to recognize any variations in the microfauna. A survey made it possible to study the transition from the "Provençal" Barremian to the "Ardéchois" Barremian, where Urgonian facies become exceptional.

Société Anonyme Française de Recherches et d'Exploration de Petrole

The laboratory of the Southern Division of Bayonne, has been engaged mainly in routine work. In conjunction with surface mapping, the stratigraphy of the Upper Cretaceous flysch has been studied and local correlations made. Eocene microfaunas have been investigated for the same purpose. Microfacies

studies have involved principally the Jurassic section in the central Aquitaine basin. A stratigraphic evaluation of the sedimentary coves in the Western Pyrenees is anticipated for 1959. Correlation with the Spanish sequence will probabley be possible.

P. L. Allard, previously Chief Stratigrapher of the S.C.P., has been in charge of the laboratory of the Northern Division, at Dijon, since 1957. Work has been carried on mostly in the Franche-Comté area, where Liassic and Upper Jurassic microfaunas have been studied. Middle and Upper Jurassic microfacies have been used in correlation. In collaboration with G. Colom, micro-organisms referred to *Fissurina* have been investigated. Present studies still are concerned with Jurassic microfacies, but have been extended to the Senonais area, in the Paris basin. Sedimentological work on the Rhaetic is also being carried out.

Société des Pétroles de Valence

Beginning in September, 1958, the first task of the laboratory at Boung-Les-Valence (Drôme) was to establish the regional stratigraphy as precisely as possible, on the basis of a deep boring, SL 1. The study is very interesting, consisting mainly of Mesozoic sediments, which show a normal succession from the Urgonian down to the basement.

The Upper Jurassic–Lower Cretaceous Jura facies of the northeastern border of our permit have made it possible to establish correlations with our wells. The IFP "Diplôme" of M. Bramaud, published in Nov. 1958, was entitled "Study of the Mont Tournier Anticline." Good markers were found in the Kimmeridgian with "microfilaments;" in the Portlandian with *Saccocoma* and *Globochaete alpina*; and in the *Purbeckian*, a conglomerate formation with black pebbles showing Miliolidae, Valvulinidae, *Chara*, *Clypeina*, and beds with crustacean coprolithes. The Valanginian contains some microfaunas, the microfacies being more oolitic and ferruginous than the Fontanil limestone. Correlations by microfacies between wells and field studies in the Upper Jurassic beds of the northeastern border were possible from the *Lusitanian* to the *Purbeckian;* and in the *lower Valanginian* with *Valvulinella jurassica*, *Eggerella*, *Pfenderina neocomiensis*, *Cayeuxia*, *Sphaerocodiacea*, and *Lithoporella*.

Régié Autonome des Pétroles

The paleontological and stratigraphic division of the Central Laboratory at St. Gaudens, Haute-Garonne, is continuing studies of well and surface samples from various concessions in France (R.A.P.) and in the Sahara (C.R.E.P.S.). The staff includes four geologists: P. Durif, assisted by A. Artières, A. Delaval et E. Szöts. Durif has made a stratigraphic study of the upper and middle Jurassic found in wells in eastern Aquitaine. The principal markers used were *Valvulinella*, *Trocholina*, and *Pseudocyclammina*. Correlations have also been established in the lower part of the Upper Cretaceous in the "Flysch" zone from Gensac to Dreuilhe.

Szöts has examined particularly the Tertiary formations in wells drilled in Aquitaine, and has made detailed correlations in the Eocene and Paleocene. Artières has studied microfacies in the Lias of eastern Aquitaine, and has observed abundant Lagenidae in the middle Lias and the occurrence of *Frondicularia* and Polymorphinidae in the Infralias.

A detailed study of the Dogger in the Paris Basin is being carried on by Mme L. Monteil, a technical assistant. A marker horizon with *Meyendorffina* and *Orbitammina* has been observed in the Bathonian. Delaval and Durif are continuing their micropaleontological work on the Paleozoic of the Sahara. Several faunizones have been recognized in the Carboniferous of Ahnet, Azzel Matti, and the Fort-Polignac Basin; a foraminiferal fauna consisting of Archaediscidae, Trochamminidae, Palaeotextulariidae, Endothyridae, and Fusulinidae, has been observed, especially in thin sections. A preliminary study of ostracodes and conodonts has recently been started.

JEAN CUVILLIER
Laboratoire de Micropaléontologie
University of Paris

NEW ZEALAND

N. DE B. HORNIBROOK

Oil exploration activities by Shell, British Petroleum, and Todd are continuing. Shell has started drilling a well in Taranaki, which is expected to reach 8–10,000 feet; Dr. M. Gieger is providing stratigraphic control by means of small foraminifera.

British Petroleum is continuing field work on the east coast of the North Island, with headquarters at Gisborne, and is expecting to drill within the next year. Dr. F. M. Kicinski has left New Zealand and gone to headquarters in England. He has been replaced by Mr. F. C. Dilley, from Papua.

Paul Vella has left Todd Bros. Oil Exploration Division and has joined the staff of Victoria University of Wellington as a lecturer in the Geology Department. He intends to build up teaching and research facilities in micropaleontology, thus making Victoria the only university in New Zealand teaching this subject so far.

At the New Zealand Geological Survey, in Lower Hutt City, George Scott has been making quantitative studies of lineages within the genus *Rzehakina*, which is common in the New Zealand Upper Cretaceous. He believes that this work will enable him to place given population samples of *Rzehakina* in their correct stratigraphic order, and he is keen to exchange material with overseas workers interested in this genus.

Dr. R. A. Couper has left the New Zealand Geological Survey and has

joined Shell. He is at present in their palynology laboratory, at headquarters in The Hague. Microfloras of probable Jurassic age were identified recently by Dr. Couper from greywackes in the main range in Hawkes Bay.

Dr. W. F. Harris, formerly of the Botany Division, Department of Scientific and Industrial Research, is now with the Survey, and is continuing his work on Pleistocene palynology. Your correspondent is continuing his work on New Zealand Oligocene microfaunas.

Papers published recently include two by R. A. Couper, one on British Mesozoic microspores and pollen grains (Palaeontographica, vol. 103, pt. B, 179 pp., pls. 15–31, 1958), and the other in Kingma, on the tectonic history of New Zealand (New Zealand Jour. Geol. Geophys., vol. 2, pt. 1, pp. 8–9, 1959). L. H. Crosby and E. J. Ferguson Wood have published a paper entitled "Studies on Australian and New Zealand diatoms; II–Normally epontic and benthic kenera" (Trans. Roy. Soc. New Zealand, vol. 86, pt. 1, pp. 1–58, pls. 1–9, 1959). Other recent papers are those by W. F. Harris, on pollen-bearing deposits and vegetational history of the Hutt Valley, Wellington, New Zealand, as part of a symposium (Proc. New Zealand Ecol. Soc., 7th Ann. Meeting, 1958, published 1959); by N. de B. Hornibrook, entitled "New Zealand Foraminifera: Key species in stratigraphy–No. 6" (New Zealand Jour. Sci. Technol., vol. 1, no. 4, pp. 653–676, 1959); by N. T. Moar, entitled "Contributions to the Quaternary history of the New Zealand flora; I–Auckland Island peat studies" (New Zealand Jour. Sci., vol. 1, no. 3, pp. 449–465, 1958); by C. C. Rich, on the occurrence of the Geodiidae (Desmospongea, Choristida) in late Cenozoic strata of western Wellington Province (New Zealand Jour. Geol. Geophys., vol. 1, no. 4, pp. 641–660); and by G. H. Scott, on the distribution of populations of fossil foraminifera (ibid., vol. 1, no. 3, pp. 474–484).

N. DE B. HORNIBROOK
Geological Survey of New Zealand
Wellington

NORTH AFRICA

JEAN MAGNÉ

MOROCCO
Société Chérifienne des Pétroles (S. C. P.)

During 1958, the staff continued its work on well and surface samples under the direction of Miss E. Vincent and Mr. L. Brun. No detailed news has come to us this year from this laboratory, however. We assume that there were no important findings to be reported, and we hope to receive a detailed report next year.

ALGERIA
University of Algiers

Under the direction of Professor R. Laffitte and G. Lucas, the research workers of the geological laboratories of Algiers University pursued work in their various fields. Miss D. Noël has just published the results of her most recent studies on the coccoliths of the Jurassic and Lower Cretaceous of Algeria. This important work includes, among others, the description of a new family, the Brachiosphaeridae, with one genus (or manipule) and three species (or centuries), as well as eleven new forms which may belong to the previously known genera *Discolithes*, *Rhabdolithes*, and *Parhabdolithes*. This work is the completion of a series which she had published previously on the same subject.

Miss Noël is now carrying on research on the coccoliths of the Permian of Tunisia, of the Mesozoic of Algeria, and of phosphatic deposits of various ages. Under her direction, two students are studying these micro-organisms in material from the Cenomanian of the Rouen region (France) and from the Lower Eocene of Algeria.

Mr. Yves Reyre is undertaking a palynological study of the liquite intercalations in the Saharian. This research concerns a whole series of strata from the Middle Jurassic to the Albian. He hopes, by means of pollen, to be able to work out a stratigraphic scale in this very thick continental sequence.

Mr. J. Emberger expects soon to publish the results of his research on the fossil algae of North Africa. In this paper the numerous forms which he has observed in the Carboniferous of the Sahara, the Permian of Tunisia, and the Lias and Upper Jurassic of Algeria will be described and figured. Later he will describe the forms of the Cretaceous and Tertiary. His studies are directed especially toward the Dasycladaceae, the Codiaceae, and the Cyanophyceae. Under the direction of J. Emberger, Miss A. Renoult is undertaking a study of the Melobesiae of the Eocene and Oligocene of Algeria. This work, based on material from recently discovered beds, will complement the important published in 1939 by Mrs. P. Lemoine.

Mr. A. Rosfelder has directed his attention toward the morphometry of loose sediments. He has devised an dihedral, which makes it easier to measure the three orthogonal diameters of sand particles and permits rapid statistical analysis of the characteristic dimensions. Thus this dihedral makes it easier to recognize associated morphoscopic and mineralogical measurements. Mr. Rosfelder has also studied the forms and deformations of sedimentary particles from a methodological point of view.

Compagnie Française des Pétroles (Algérie) C.F.P.(A.)

The staff of the laboratory of C.F.P. (A.) was increased by two geologists in 1958. An assistant, Mr. Rouge, from the I.F.P., was engaged for Mr. V. Sacal, and Mr. Thouvenin now has Mr. Lehmann as his collaborator. Miss Nabos left the laboratory at the end of 1958, and was replaced by Miss Deny.

The activities of the C.F.P.(A.) were concentrated chiefly on the study of the Triassic and Cambro-Ordovician sandstones that form the oil reservoirs in the Sahara. In the absence of paleontological data, the staff was obliged to undertake detailed petrographic studies, which, after long and tedious research, provided highly satisfactory bases for stratigraphic correlation. The detailed study of granulometry, morphoscopy, and especially of the percentage and composition of sandstone cements enabled the staff to make good correlations, even over distances in the sandstone sequences of the Cambro-Ordovician. Sedimentological studies on Triassic sandstones are in progress, and the laboratory is attempting to differentiate the various beds of sandstone by the mode of transportation of their detrital material.

The laboratory at Algiers has the benefit of the advice and guidance of Professor J. Cuvillier in its activities in the field of stratigraphy. Mr. R. Passega is the advisor in sedimentological work.

Compagnie des Pétroles d'Algérie– A.P.A. (Royal Dutch/Shell Group)

During 1958 the paleontological laboratory of the C.P.A. worked on problems of Paleozoic stratigraphic paleontology. Useful results were obtained by a combination of palaeontological and palynological methods with rocks as old as Cambro-Ordovician. Mr. M. Millious, who had directed the laboratory for the previous four years, assisted by L. Nijssen, was replaced toward the end of 1958 by Mr. A. J. Whiteman, recently with the Geological Survey and Museum of Great Britain.

Service de l'Hydraulique et Équipement Rural (S.H.E.R.)

The laboratory of micropaleontology of the S.H.E.R. had the same staff during 1958 as in the previous year. Work was carried out under the direction of Miss C. Pinard. Several wells penetrating the continental formations of Qued Rhir and of the "fosse sud-aurasienne" in the Sahara made it possible to obtain some interesting information on the Eocene basement of this region. A study by Miss Pinard, in collaboration with Mr. N. Gouskow and Mr. A. Cornet, field geologists of the survey, was published recently (C. R. Somm. Soc. Géol. France). Miss Pinard also studied the microfauna of the Upper Miocene as observed in several water wells in the Oranie (West Algeria). A more detailed report will be given next year.

Société Nationale de Recherche et d'Exploitation des Pétroles en Algerie (S.N. REPAL)

The great development of research in the Sahara, where all the activities of the S.N. Repal have been concentrated, has required an increase in the various categories of the staff of the central geological laboratory, directed by J. Magné. Five new young geologists were engaged in the course of 1958. Toward the end of the year, the staff was composed of eight laboratory geologists, four assistants, one draftsman, two photomicrographers, two secretaries, and eleven laboratory helpers. A total of about 4,600 washed samples, 8,000 thin sections and 500 preparations of heavy minerals were studied.

A palynological section of the laboratory was established recently. This section, with Mr. E. Kossenko in charge, undertook the study of spores, pollen, Chitinozoa, and hystrychospheres from the different Saharian formations, mainly Paleozoic and Mesozoic, to solve problems of correlations and microstratigraphy.

Work on other microfossils (foraminifera, ostracodes, eopteropods, and charophytes) was carried as in previous years. The staff also continued the study of microfacies and heavy minerals.

In spite of a large amount of time consumed by routine work, mainly on oilfield development drilling, some interesting research may be mentionned. Mrs. S. Gassier-Chastanier, assisted by two new laboratory geologists, Mr. J. P. Bertrand and Mr. P. Moreau, carried out a study of Saharian Paleozoic sequences from a sedimentological point of view. They examined chiefly Cambro-Ordovician formations. Mrs. Gassier-Chastanier also studied numerous samples from the western and southern part of the Sahara (north edge of Hoggar, In Guezzam, and Fort-Polignac regions). Miss O. D. Bazoche, another new young geologist, has resumed the detailed study of Paleozoic Ostracoda and foraminifera of the marine Carboniferous (Visean to Moscovian) of the Sahara, which had been begun by C. Tempère.

Mr. A. Novikoff continued his petrographic work on the Triassic formations of the Sahara and obtained good correlations between wells. Mr. E. Kossenko has already obtained good results with palynological methods in the research on the Jurassic/Cretaceous contact in the continental facies. His work will be increased during 1959.

Mr. J. Magné began a study of conodonts from the Paleozoic of the Sahara and of the Grande Kabylie (North Algeria). In the latter region he discovered these microorganisms for the first time. Magné has completed a detailed study of the microfacies and microfossils of the Mesozoic and Tertiary of the northern Sahara, with the collaboration of Miss J. Thibaut of the C.P.T.L. (Libya). The principal results will be published in the International Sedimentary Petrographical Series directed by Professor J. Cuvillier and Dr. H. M. Schürmann. With the assistance of G. Mas, your correspondent also established a good stratigraphic scale for the Saharian Jurassic, based on Ostracoda. He also studied the foraminifera of the Neogene and Numulitic of the Cordillères Bétiques or southern Spain.

In September, 1958, Magné attended the 5th international micropaleontological colloquium, which met in northern and central Italy. Your correspondent visited famous localities such as Asti, Piacenza, Tortona, the Bottacione Valley, etc., under the guidance of the Institute of Paleontology of Milan.

At the end of 1958, your correspondent left the S.N. Repal to become the head of the Central Geological Laboratory and of the Paleontological Survey of Esso-Rep, in Bégles, near Bordeaux, France. A young micropaleontologist, Mr. J. Deumié, student of Professor Cuvillier, was engaged in November.

TUNISIA

Société de Recherche et d'Exploitation des Pétroles en Tunisie (S. E. R. E. P. T.)

Drilling activities during 1958, involved the laboratory principally in the study of the older Paleozoic. Micropaleontology occupied only a small part of its work, and the laboratory therefore adopted the name "Laboratory of Geology." It has been directed since September, 1958, by Mr. J. Rabaté, who replaced Mr. C. Glintzboeckel, now chief of the geological laboratory of the new oil company C.O.P.E.F.A. in Marseille, France.

Mr. Rabaté has been assisted since July 1958, by Mr. Macoin, a former student of Professor Cuvillier.

The Permian and Carboniferous of Tunisia provided no new or interesting data during the past year. However, the stratigraphy of the older Paleozoic was established. The Devonian was found to be quite rich in ostracodes and brachiopods. A stratigraphic scale based on brachiopods is in progress; it will make it possible to establish the value of the ostracode microfauna (most of them new) collected in these formations. The Gothlandian was well worked out by means of graptolites. The Ordovician showed some good stratigraphic markers both in sedimentology and in fauna. The Leandeilian Tremadocian have been especially well dated, the former by trilobites and graptolites, the latter by Lingulas. The granulometric studies of the Cambrian made by Mr. Bonnefous permitted good correlations in sequences composed exclusively of sandstones.

JEAN MAGNÉ
Esso-Rep
Bégles (Gironde)
France

PAKISTAN

Micropalaeontological studies are at present being carried out by the Geological Survey of Pakistan and by the petroleum companies operating in Pakistan, which include the following: Hunt International Oil Company, Pakistan Oil Fields Limited; Pakistan Petroleum Limited; Pakistan Shell Oil Company Limited; Pakistan Sun Oil Company; Standard Vacuum Oil Company; Tide Water Oil Company. Micropalaeontology is being taught at the University of Karachi and the University of the Punjab, Lahore.

Pakistan Petroleum Limited (a subsidiary of the Burmah Oil Company Limited) and Pakistan Oil Fields Limited (a subsidiary of the Attock Oil Company Limited) have been doing exploration research, including palaeontological studies, for more than twelve years. The Tide Water Oil Company and the Pakistan Sun Oil Company, however, have arrived recently. The Tide Water Oil Company is now busy setting up palaeontological and other laboratories. The activities of these organisations are as follows:

Hunt International Oil Company

All micropalaeontological work of this company is carried out in the United States.

Pakistan Petroleum Limited

M. H. Khan has joined Pakistan Petroleums. He was given the task of setting up a palaeontological laboratory at Karachi. Formerly all palaeontological investigations were carried out at the palaeontological laboratory of the Assam Oil Company at Digboi. Khan spent some time at the Assam laboratory, and assembled a representative type collection to serve as a nucleus for the laboratory at Karachi. The Karachi laboratory is now well established and is handling the palaeontological examination of all the well and surface samples, under Khan's direction.

Pakistan Petroleum has done considerable drilling during the past three years, and, as a result, most of Khan's time has been devoted to routine palaeontological examination of well samples. Detailed studies of the foraminiferal faunas of the Tertiary and Mesozoic subsurface succesions encountered in various wells are, however, proceeding. Khan and your correspondent will shortly undertake a joint study of Cretaceous small foraminifera from wells drilled in Sind.

Pakistan Shell Oil Company Limited

Palaeontological work was started in 1957, when W. O. Gigon and J. A. Postuma established a laboratory at Karachi. Since then, their work has been concentrated on larger and smaller foraminifera from the Tertiary and Cretaceous of West Pakistan.

Standard Vacuum Oil Company

The Palaeontological Laboratory of this Company was started in 1955, with D. D. Bayliss and D. J. Carter. Most of the investigations were more or less confined to the study of the foraminifera. E. P. Dubois took charge of this laboratory in 1957.

Company consultants in the United States noted the possibility of correlating the Cretaceous and Jurassic rocks on spores, pollen, hystrichospherids, and dinoflagellates. G. G. Wissema joined his laboratory late in 1958, from the Company's office in Indonesia. He is setting up a palynological laboratory for work on these microfossils from surface and well samples.

Tide Water Oil Company

Tide Water began an exploration program in West Pakistan late in 1958. Edward B. Fritz is the palaeontologist of this Company. He arrived in Pakistan late last July to set up a palaeontological laboratory. He will be concerned with the examination of routine surface and well samples from the lease area of the Company.

University of Karachi

Since late 1957, when courses in micropalaeontology were first introduced at Karachi, W. O. Gigon, of the Pakistan Shell Oil Company, has been teaching micropalaeontology at this university on a part-time basis. In 1958, E. P. Lehmann joined the department on a temporary assignment. Since 1959, qualified students have had an opportunity to choose a topic in micropalaeontology for their M. Sc. thesis.

University of the Punjab

P. Marks has joined the faculty of University of the Punjab, and is primarily concerned with the teaching of palaeontology. Micropalaeontology is another subject which Marks will also be teaching.

A. Latif has been working at the Imperial College of Science and Technology, London, on smaller foraminifera from the Rakhi Nala, Dera Ghazi Khan District, West Pakistan. He is being guided by D. J. Carter.

Geological Survey of Pakistan

Your correspondent has completed a study of smaller foraminifera from Upper Cretaceous, Eocene, and Miocene rocks at selected localities in West Pakistan. The results of this study are expected to be published by the Geological Survey in the near future. This work was carried out at the Smithsonian Institution in Washington, D. C., under the technical assistance program of the U. S. International Cooperation Administration. A micro-palaeontological laboratory is being established by the Geological Survey of Pakistan at Quetta.

A. F. M. Mohsenul Haque
Geological Survey of Pakistan
Quetta

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